PRACTICAL
COTTON MILL
MANAGEMENT

Revised and Enlarged
particularly the Chapters
on
Yarn and Cloth Costing,
Designing
and
Questions and Answers.

PRACTICAL COTTON MILL MANAGEMENT

BY

B. S. BENJAMIN

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CHAPTER XXIV.

"CLOTH MANUFACTURE."

There are few mills in India with weaving shed alone, the usual method being to combine Spinning and Weaving Mills. There are several mills that have their own dying and bleaching departments attached to them too. Nearly every weaving mill has its own calendering and finishing departments.

All surplus production of the spinning department is reeled for export and sold locally generally in the grey state. It is sometimes bleached or dyed according to demand. A large quantity is also doubled such as 2/40s dyed and used by those weaving mills that are engaged in 'Dhoti' trade, etc. The yarns used in weaving are usually standardised. There will probably be two or three different counts of twist and two or three different counts of weft. For example. 14^s and 22^s twist, 14^s, 16^s, 26^s and 30^s weft. Or, 20^s twist and 30^s weft. Or. 20^s 32^s, 40^s and 82^s twist and 30^s 42^s, 60^s and 100^s weft. These counts are generally used for manufacturing, Long cloth, Shirtings, Dhoties and Sarees of both coarse and fine quality.

Each count of yarn is spun or wound on different coloured ring or warper's bobbins. The idea is to prevent both waste of yarn and time. But still the average mill hands can hardly tell the difference, say to 4 or 6 counts, in spite of different coloured bobbins, unless it is pointed out to him or her, or the count is marked on the box by means of a ticket bearing the count in print.

Ring yarn is in general use in the majority of the mills in India, both twist and weft. They are spun on a wooden bobbin, on a ring frame in successive layers, the traverse of each succeeding layer being slightly shorter than the one just before it.

There are very few mills where mules are still found but the mule yarn is reeled for export purposes or dyed or used as weft yarn chiefly, for weaving blankets etc.

The warp yarn, sent from the ring frame to the grey winding machine of the usual vertical type, is delivered to each winder in doffs varying in weight according to counts. A doff of 20s consisting

of about 32 pounds. Immediately on receipt of warp or weft yarn in skips, each skip should be weighed, and the weight recorded in a book kept for that purpose to be tallied with the weight received from spinning department.

Yarn may be spun twist way or weft way. If the warp thread or twist is held between the fingers and thumbs of both hands, and the right finger and thumb are turned in a direction away from the body, the thread will untwist.

If the weft thread is held in the above manner, the right fingers will have to be turned towards the body so as to untwist the thread. In India both warp and weft whether grey or coloured are spun in the same way, that is, twist way.

In judging twist yarn preference should be given to the most even thread, soft spun, good test, with plenty of elasticity, round and free from motes, soft places, snarls, etc. As a general rule twist yarn is finer and stronger than weft yarn of corresponding staple and counts. Warp yarn requires to be stronger than weft to enable it to withstand the greater-amount of tensile strain and abrasion friction to which it is subjected during its conversion into warp and especially during the operation of weaving. Its greater strength results from a greater amount of twisting being imparted to the threads during the operation of spinning, where-by the fibres composing them become more firmly interlocked and cohesive, there-by increasing their power of resistance to both tension and friction.

Textile threads become thinner when subjected to tensile strain, but if they are not extended sufficiently either to dislodge or rupture the fibres composing them, they will recover their normal state on being relieved of such tension. For these reasons it is essential that yarn intended for the production of warps should never be subjected to such a degree of tensile strain as will destroy or even impair its elasticity.

Storage of weft—weft should always be stored in a damp room, preferably in a cellar and in some cases it may be found necessary to steam the weft.

The weft room should always be located on the same ground—level as the weaving shed and it should be central to the weaving shed, so that, the weavers may not have to waste time by going a long distance in getting the weft. If possible the weft should be distributed to the weavers at their looms.

Yarn Testing—Accurate testing of both warp and weft yarns, is of the utmost importance. Nothing should be taken for granted and no skip that is received from the spinning department or imported yarn should be passed over. A number of bobbins or cops should be tested on the wrapping machine and a proper record kept of all the tests that are made from day to day with full details of marks or numbers. When testing yarns for uniformity in diameter and general condition, it is advisable to use a yarn tester that winds the single thread, equally spaced, on a piece of black cardboard.

THE ROUTINE OF CLOTH MANUFACTURE.

Cotton yarn, before it is manufactured into cloth, has to go through the entire routine which comprises the following series of five operations with the exception of drawing in even this can now be done mechanically, by Barbar tieing machine which is chiefly useful where plain weave (4 shafts) is greatly in vogue. All the operations are performed mechanically :—

(1) *Winding*—to transfer yarn from mule cops or ring bobbins on to warper's bobbins.

(2) *Warping*—to transfer yarn from warper's bobbins on to warper's beams.

(3) *Sizing*—applying size to yarn and winding warps finally to weavers beams.

(4) *Drawing-in* the passing of warp threads through the eyes of healds and reed dents.

(5) *Weaving* starts to weave the cloth when the warps is gaited on the loom.

GREY WINDING.

The function of the Winding department is to pass the yarn forward, in a form in which it is most suitable for the subsequent operation. During the passage of the yarn through the preparation department some of the spinning defects should be removed, and the various operations are carried out efficiently. The warp yarn should reach the weaver with all threads straight and at a uniform tension. It should contain no bad knots, neps, impurities, or weak places, and still retaining its elasticity which is very essential for good weaving.

Unless the preliminary operations are carried out efficiently and well, decreased production in the weaving department is bound to follow, good preparation means increased production in the weaving department and more saleable cloth, both of which are desirable.

To avoid over-tension is the secret of success of winding, warping and sizing. The grey winding machine has down each side two rows of vertical steel spindles (200 spindles per frame, these can be less or more) fitted with wharves and washers which are turned and polished and driven by cotton bands. Each spindle requires a separate band from a central tin-drum which may be 5 or 6 inches in diameter.

The back rows of spindles have wharves larger than those fixed on the spindles in the front rows, so that the back rows of spindles will revolve with a slower velocity than those of the spindles in the front rows. The diameter of the wharves on the front spindles is usually $1\frac{1}{4}$ inches and that of the wharves on the back spindles $1\frac{1}{2}$ ins. hence their velocities will be in a ratio inversely to those diameters or as 6 to 5 respectively. As the bobbins on the front spindles become half filled with yarn, the winder should remove them on to the slow-running back spindles to be filled. Assuming the velocities of front and back spindles to be 648 and 540 revolutions per minute respectively, and that a bobbin is half-filled on a front spindle, and then removed to back spindle to be filled, yarn would be wound at the rate of 72 yards per minute at the commencement, and at the excessive rate of 240 yards per minutes at the end of winding, when a bobbin is quite filled with yarn. These velocities are therefore in the ratio of 1 to 3.33 respectively.

As a basis, medium counts, say 40's should be unwound at the rate of 120 yards, finishing at the rate of 170 yards per minute on the front spindles, and when transferred to the back spindles the speed should be the same. It is not desirable to run winding machine too fast since slower speed tends to maintain the strength of the yarn leaving it more elastic and causing fewer knots in the warp. This important factor is more often than not totally lost sight of.

A weaving master is often compelled to extract spinner's faults for the purpose of improving the quality, quantity and appearance of the finished product, but very often over-reaches himself and gets broken threads, orthe fibres are stretched out of proportion. Spinner's

ordinary faults are bad enough when going through the warping, sizing and weaving, but not so great as those arising from a weakened thread one with its back continuously broken by excessive speed and drag. The greater the speed the less the production. No weaver can be expected to produce good cloth from badly prepared beams.

It is a fact that no yarn is fit to go into work unless its strength stands the 'Lea' pull of the acknowledged dividend, *viz.*, 1400 for Indian cotton, and 1800 for American cotton, adding 5% for Egyptian cotton, over American test.

If the test is lower, then it is the fore-runner of trouble unless extra care is taken by a reduction of speed.

It is also necessary to point out that the counts after winding will be finer than before winding owing to the stretch on the yarn during its passage through the machine, and the scraping off of the loose fibre. Winding also helps to even out the twist in the yarn.

Abrasive friction acts detrimentally upon the quality of the yarn, and tends to weaken it by dislodging the fibres of which the threads are composed and also upon the elasticity which is one of the most valuable elements and essential to good weaving, and hence it should be avoided. On the other hand, if yarn is wound with a subnormal degree of tension and thus producing very soft bobbins, they not only incur excessive waste but they also greatly impede the progress of winding and warping. Because if a thread breaks on a soft-wound bobbin, it is liable to cut deeply into the soft layers of yarn and thus become embedded and lost, instead of lying freely exposed on the surface. The warper or winder will then endeavour to recover the lost thread by scratching along the surface of yarn. This sometimes causes the broken thread to reappear several coils out of its proper place and thus create the evil known as 'lapped ends'; whereas to find the broken ends a thread should be broken in another place, and then unwound from the bobbin until the broken end reapears on the surface. But some unscrupulous winders resort to the objectionable practice of breaking the thread in another place on the warper's bobbin to obtain a free end for piecing up, or else they will resume winding on the faulty bobbin without piecing the thread, and thus leave the task of recovering the lost thread o be encountered subsequently by the unfortunate warper.

It is necessary to exercise care in adjusting the drag from the ring bobbin or hank to the warper's bobbin in the winding frame, so that the yarn retains its strength for good beaming, sizing and weaving. It is rather better to wind the bobbin a little on the soft side than as hard as stone, as in the former the greater part of the elasticity can be retained while in the latter case by too much drag the greater part of the elasticity is lost. The primary object or the function of a winding machine which is invariably attended by female operatives, is, to obtain separate and continuous threads or ends of considerably greater length than that in which they are found during Spinning. Thereby the handling in the subsequent department, i.e., warping is more facilitated on account of the compact form which is effected by tying together the ends of any number of separate threads. In other words it consists essentially of transferring separate threads from any of their previous forms and winding them on to flanged warper's bobbins according to the type of winding machine employed.

The number of winding spindles allotted to winders varies from 20 to 35 each, according to age, ability and other circumstances.

The weight of yarn on a ring twist bobbin is approximately 1 oz. 3 drs. of 20s. There is from 2500 to 2700 yards on a mule cop of 30s.

The maximum weight of yarn which may be placed on a warper's bobbin depends upon the size of bobbin, the counts, and character of yarn, whether hard or soft twisted and the degree of tension imparted to it during winding. A warper's bobbin with flanges $3\frac{1}{2}''$ diameter, $5''$ lift and $1\frac{1}{4}''$ barrel will hold approximately 1 lb. of 20s ring twist yarn.

The self-contained type of vertical spindles are in common use. The flannel covered knee—board with T-guide is generally used although some of the frames have metallic brushes attached to the guide rails, for the purpose of cleaning the yarn instead of the knee-board. There are several devices on the market for the purpose of improving the quality of the yarn. The adoption of a device chiefly depends upon its merits and what it can do both with good and inferior quality of yarn, as the quality may not be two days alike, and very often varies, though it may be received from the same spinning mill, much depends on the staple of cotton used and the various staple cotton blended together to form a mixing; also the quantity of waste that has been added in the mixing, plays a very important part both in the out-turn of the spinning and weaving departments.

PRINCIPAL FACTORS FOR ASCERTAINING QUALITY OF YARN.

The quantity of fluff and dirt found under a winding frame and the breakages observed during the winding process and more so during the warping process where the tension is much greater are the three principal factors to be taken careful notice of for ascertaining the quality of yarn. Therefore it is absolutely necessary daily to regulate the tension and adjust the cleaning devices according to the quality of the yarn. The more the weak places are removed from the yarn during the winding process (but bear in mind without over-stretching the yarn). the better it is. The brushes and the flannel on the knee-board should be removed as soon as they are required or necessary. Spindles should not be left to run for extremely long periods without cleaning and re oiling. Good quality of oil should always be used.

Colour of Bobbins Should Indicate the Counts of Yarn.

It is wise to run one count on one whole winding frame and not two or more counts on the same frame, or different colours of bobbins should be used for different counts so that the mixing of bobbins by the winders is avoided or minimised, otherwise it will cause unnecessary annoyance and loss of production to the warper.

Each bobbin from every winder should be marked with the number of the winder on both the flanges of the bobbin with chalk to enable an offender to be traced and punished, should it be necessary to do so. A correct size of bobbin adjustable to the various counts of yarn is absolutely necessary. Very great laxity is observed in some of the mills in that they try to make one large size of bobbin do for both fine and coarse yarns -only distinguishing the counts by colours.

What happens ? Coarse counts go along productively, while fine counts are unproductive through the heavy bobbin, overbalancing the calculated strength of yarn. It has never been pointed out that the stretch in the unwinding is twice as great at the beginning as it is at the finish. It should not be overlooked that a bobbin works at its best when filled with a little over the length required on the beam. Bobbins should be small and light in weight.

The bobbins on a winding frame should not be wound too full, or they may increase the percentage of waste.

Counts of yarn.	Dia. of Flange.	Dia. of Barrel.	Lift.
70's to 80's	$2\frac{1}{2}''$	$1\frac{1}{4}''$	$5''$
50's to 60's	$3''$	$1\frac{1}{4}''$	$5''$
40's to 48's	$3\frac{1}{4}''$	$1\frac{1}{4}''$	$5''$
30's to 38's	$3\frac{1}{2}''$	$1\frac{1}{4}''$	$5''$
14's to 28's	$4''$	$1\frac{1}{4}''$	$5''$

It is much better to have a few extra spindles than to strain the yarn by endeavouring to run it through a few spindles. It is advisable to have, if possible, the number of spindles on both sides of the winding frame equal to the number of spindles on one side of the spinning frame. By this means one doffing of a spinning frame will supply two rounds to the winders, and all the spindles are kept running in both frame.

One doff will be completely used before another one is started on. In this manner bad bobbins or poor doffing will be traced more readily.

Loss in percentage due to moisture contained in 1 lb. of yarn.

Loss in ozs.	Percentage of moisture.
$\frac{1}{8}$	.8
$\frac{1}{4}$	1.5
$\frac{3}{8}$	2.3
$\frac{1}{2}$	3.1
$\frac{5}{8}$	3.9
$\frac{3}{4}$	4.7
$\frac{7}{8}$	5.4
1	6.2
$1\frac{1}{8}$	7.0
$1\frac{1}{4}$	7.8
$1\frac{3}{8}$	8.6
$1\frac{1}{2}$	9.4
$1\frac{5}{8}$	10.1
$1\frac{3}{4}$	10.9
$1\frac{7}{8}$	11.7
2	12.5

Defects to Look for.

Ridgy, nicked, or bulged bobbins should be searched for, and the excessive vibration of spindles, loose racks, pinions, and worm cams which contribute to these bobbin defects should be rectified by giving attention very carefully to the machine. Soft bobbins are caused by defective tensioning of the yarn, and the tensioning devices used must be examined for defects. In the ball-drag type bits of fluff will cause uneven tension to be placed in the yarn.

There are several other defects that may appear in the yarns before the latter leave the winding department, and such defects may be grouped into two main classes, viz., (a) those on the yarns themselves due to large knots or imperfectly—made knots and (b) those present on the warping bobbins, cheeses or cones.

The fact should always be borne in mind that a large knot or slub cannot pass easily through the eye of the heald, or even through the dent or split of the reed; nor can the knot resist for any great length of time the repeated chafing and scraping of the reed wires, especially if the knot appears on a thread at or near the selvedges of the cloth.

One of the main objects, therefore, of all the operatives in the preparing department should be to make a small knot, with the shortest possible "tails."

Certain bobbins will be noticed to bulge considerably while the rest may possess the correct contour. In such instances the tee-headed guide screws require proper adjustment, and this will cause the running-over to cease. Difficulty in tuning the motion is often experienced by the jobber or mistry. It should set so that the small pinion is opposite the mangle crab wheel, when the yarn is winding on to the centre of the bobbin. In the case of the heart cam motion the bowl should be set to operate midway between the extreme points of the cam.

" Characteristic of Yarn. "

The characteristic differences between various classes of cotton yarns may conveniently be divided into classes, (1) those which are 'desirable' because they help to produce the effect or appearance required in the woven fabric; and (2) those which are "undesirable" because they depreciate the value of the cloth in which they appear, and therefore are properly described as faults.

Desirable Features—The desirable feature of cotton yarn depend largely upon the ultimate use to which the yarn is to be put, and in determining these it is necessary to consider the finished product. For instance, yarn to be spun for the manufacture of flannelette requires to be different from that for the weaving of tennis shoe tops, although the counts of yarn and sort of cotton used may be similar in many respects. Then there are the differences between the warp and weft yarns for velveteens or corduroys; between hosiery yarns, and voile or Crepe yarns.

"*General Good Qualities*"—The general good qualities of cotton yarns are comprehended on the measure of their cleanliness, elasticity, strength, eveness or regularity, correct counts, correct twists or turns, appearance or colour, fullness, roundness, etc.

Correct Turns or Twist—The amount of twist has a very important influence upon the finished product, and the number of turns per inch often determines the suitability of a certain yarn for a specified purpose.

Soft twisted yarns are required for hosiery or knitting; for flannelette or other similar cloths which are raised to produce a nice feel or appearance—as weft for velveteens, corduroys, etc.

Hard twisted yarns are used for crepe, voile, collar or imitation linen cloths, and many kinds of warp yarn for special purposes, etc.

But to take the case of the yarns for the production of ordinary class of goods, say, 30's to 36's twist and 34's to 40's weft. Twist yarn must be strong enough to weave without excessive breakage, or the cloth will be ruined, but the number of turns per inch should be as low as possible consistent with the strength required. The 'turns per inch' should be under the recognised 'standard' rather than over. If the warp is too hard twisted the cloth produced will be hard and unkindly to handle; 'bare', or poor-looking, and will feel thin. The sizing operation will be difficult to regulate, and the size will be liable to rub, or dust off either in the loom or cloth warehouse. It is impossible to produce nice "Sized Shirtings" if the twist is "hard twisted" That is why "mule" yarn is preferred to "ring" in many cases. The warp is liable to snap in either very hot or very cold weather.

Yarn Faults.

"Cleanliness" is not necessarily the most important feature of cotton yarn, but it is always a desirable consideration. In the case of a bleaching or printing cloth it is absolutely impossible to produce

a nicely finished cloth unless the yarns from which the cloth is made have been properly cleaned in the scutching and carding processes. It probably seems a long way from the carding engine to the bleach-works, or even to the shop counter. But yet it is a fact that when the cotton leaves the carding engine, unless it has been thoroughly cleaned, it will never be cleaned at all. It is safe to say that fully 90% of any foreign matter left in by the card will find its way into the cloth in the grey state, and a great proportion will finally pass on to the shop counter, even after it has been bleached and finished. The bleaching process may whiten the colour of these impurities, but they are still there and show up to disadvantage against the clean yarn. But if the material is dyed or printed upon, these impurities do not absorb the dye, and are liable to appear as specks upon the coloured fabric.

"*Evenness*"—A yarn should be of exactly the same diameter, weight, bulk, or thickness along its entire length. If a cloth is composed of uneven yarns, then an uneven fabric must of necessity be produced. This is a feature which in many cases does not appear of any great importance in the grey or loom state cloth, but it is most noticeable when the cloth is finished or dyed. It is one of the most frequent causes of complaint between manufacturer and customer.

Broken cops—Due to careless handling, packing or skewering.

Dirty Yarn.—Bad cleaning at carding process, careless handling in transit from machine to machine. Piecing up rovings and threads with dirty fingers.

Irregular colours—Due to wrong mixing of cotton.

Irregular diameter—Due to irregular drafts and twist.

"*Oil stains*—From splashings of oil thrown out by rapidly revolving spindles, shafts, etc., careless oiling of moving parts.

"*Shady weft*"—In cop dyed yarns chiefly due to the dye not penetrating evenly through the yarn. May be due to choked dyer's skewers or the use of unsuitable paper tubes, iregular tension of yarn. or too tight winding of yarn.

"*Snarls*"—These are small kinks or curls in the thread generally due to slack tensioning at various machines.

"*Specks or undyed yarn*"—Occur chiefly on dyed yarn and may be due to dead cotton or immature fibre in the yarn.

"*Thick places*"—Due to lack of twist giving soft thick places termed slubs or due to fibre or waste being picked up by the thread during spinning.

"*Thin places*"—Due to hard-twisted portions of yarn. Folded yarns may consist of singles due to failure of one of the threads.

In practice, the really thin parts of a thread should occur on an average about once in 1000 yards. Excessive tension merely stretches the yarn, creating new thin places and rendering the yarn more liable to breakage in subsequent operations.

"*Weak yarn*"—Due to overstrain or tension in some process of preparation, the elasticity of the thread being destroyed. Not sufficient turns of twist per inch. Using cotton with too short a fibre.

"*Seed particles*"—embeded in the yarn. The presence of loose fibres which gradually accumulate on the flannel—covered drag board and near the clearer.

"*Elasticity*"—in yarn is the characteristic which enables it, when stretched a certain distance, to return to its original length again. This is valuable, because it enables the yarn to respond to strain without being injured in any way. This strain occurs during shedding and beating up.

"*Large Knots*"—These are due to careless tying which may cause breakages in warping, sizing, and weaving by getting entangled round the other threads.

"*Soft Bobbins*"—The cause of this is due to wrong drag with the result that the end breaks during unwinding in the warping frame.

Wrong shaped Bobbins—When these occur the traverse motion is not set correctly and again cause breakages during unwinding.

"*Soft places*"—These should be taken out in the winding process as much as possible without injuring the elasticity of the yarn, otherwise the thread will break in one of the later processes. If the soft place breaks in the warping machine it has to be stopped until the repair is made and very often the worker will not take the trouble to tie the broken end especially when there is a lack of supervision. There will be a missing thread in the sizing and the loom and consequently more trouble for the weaver. If there are too many of these soft places in the yarn the cause of the fault should be looked for in the spinning department.

"Faults in the Machine."

Spindle band should be made from the finest cotton. Many of the mills produce their own banding, but very often being the product of a coarse yarn, spun from poor cotton, it stretches considerably with the result that spindles are likewise retarded at different speeds with an inferior quality of outturn.

Shape of bobbin—If the traverse given to the thread guides is not sufficiently great, soft places at both the top and bottom of the warper's bobbins will result. If the length of the traverse is correct but so set that it runs up too high, a hard place is formed at the top of the bobbin and a soft place at the bottom. If the length traverse is correct but runs down too far, then the opposite effect is produced. Care should always be taken to have the bearings of the lifting-rods well lubricated. If these are sticking which is caused by falling fluff the bobbins will not be filled correctly. The winders should never be allowed to tie too big a knot or a knot with long ends. In the former case in the process of weaving the thread is broken because it is too big to pass the heald eyes and reed wire of the loom. When this happens in the loom especially if the yarn is fairly strong the freed end almost always becomes entangled with the adjacent threads, and quickly causes the thread to interweave more tightly than its neighbours and thus produces an uneven place which may become very noticeable in the cloth. Long ends to knots are liable to form entanglements amongst the threads with the result named above. Snicks and snarls have similar but less disastrous results to knots.

Traverse of guide Motion—The Speed of the traverse guide rail is usually decreased as it reaches the centre of the lift and increased towards the flanges of the bobbin to form barrel shape having more yarn. A travelling apron is attached to carry on empty bobbins and thus they are collected at one of the end of the frames in a basket into which they are dropped as the bobbins come to the end of their journey.

"*Duties of an Overseer*"—It is absolutely necessary for the overseer of a winding department to see that the ring bobbins are emptied of yarn before being returned to the spinning room and not use a knife to cut the yarn that are carelessly left on the bobbin's bottom. The winder must be insisted upon to finish every bobbin right through. If a knife is used on the bobbins or weft pirns it is

detrimental to a good spinning because it will form nicks on the ring bobbins or weft pirns. There should be no yarn or bobbins thrown on the floor. Because it makes the room look so untidy. Waste yarn should be retained or kept clean to be sold as waste of good quality otherwise should there be a little dirty or oily waste mixed with good waste, then it can only be sold as second quality and hence the company suffers a loss thereby.

"How to Change Lift of Winding on Bobbins."

In order to change the bigger lift of the bobbins, the bigger diameter of the balls or more number of teeth in vertical rack and rack wheel should be changed and *vice versa*.

The changes that are required to be made when changing from coarser to finer counts are as follows :—

(1) Speed should be increased in accordance to the quality of yarn.
(2) Put less drag on the knee—board.
(3) Lessen the speed of the traverse bar with guide plate.
(4) Winders should be given more spindles to mind.
(5) The Humidification should be increased.

"*Waste*"—The percentage of loss through waste ought not to exceed $\frac{1}{4}$ to $\frac{1}{2}$ per cent in the case of ring bobbins and $\frac{3}{4}$ to 1 per cent in the case of mule cops on an average of 20's counts. Of course the percentage of waste varies as counts vary and the quality of yarn varies.

"*Depreciation*"—The general depreciation of a winding machine, however, including the cost of keeping the working mechanism in efficient order, of spindles banding, of winder's listing, of oil and all other incidental details, will probably not exceed 10 per cent, per annum for a machine containing ordinary spindles, and 8 per cent for a machine containing Rabbeth spindles.

Power = $\frac{1}{3}$ to $\frac{1}{2}$ I.H.P. for 100 Spindles.

Electric drive for the preparatory process of the weaving department.

One 60 B.H.P. to drive the following machinery.
10 Grey Winding Machines of 200 spindles each.
5 Warping machines 9/8".
5 Drum Winding machines of 40 drums each.

10 Universal winding machines of 20 Spindles each.
8 Sizing machines 9/8s.
4 Flour steeping Becks.
2 Clay Pans.
4 Finishing Becks.

Speed—The speed varies according to the type of spindles, counts, and character of yarn, the degree of tensile strain that is desirable to impart to the yarn during winding and the size of warper's bobbins. The spindle Velocity for an average of 24s counts of Indian cotton may safely be taken as 708 for front and 640 for back spindles as revolutions per minute. The speed of the machine may be taken as 130 R.P.M.

In any case, a relatively low spindle velocity is to be preferred, with a proportionately greater number of winding spindles to meet the demand. By adopting that course the elasticity of the yarn will be better preserved, also, it will conduce to fewer breakages of yarn and fewer knots, and thereby produce warps that will weave better, and make superior, cloth.

Production—The production varies according to the spindle velocity, the count and quality of yarn, and the ability of the winders But a winder can do on an average of 100 to 120 pounds per day of 10 hours per 25 spindles on an average of 22's counts.

Ratio of Spindles to Loom.

2 to 3 Spindles per Loom of 20s to 30s.
3 to 4 ,, ,, ,, ,, 40s.

The number of winding spindles required to supply the requirements of one loom will vary considerably under different circumstances, and will be determined chiefly by the counts of yarn to be wound, the number of warp ends and picks in other words Reed and Pick per inch in cloth, the speed of winding spindles and of the looms.

Average wage drawn per month per male winder about Rs. 22.
,, ,, ,, ,, ,, ,, female ,, ,, Rs. 19.

A WATCH MUST BE KEPT.

The weaving master, or the manager or the proprietor, should keep himself well informed of the following points in order to obtain the maximum production :—

(1) Whether the yarn is good or bad ;

(2) Whether the speed of the spindles remains constant throughout the day. If the speed fluctuates due to bad coal or any other reason keep a regular record of the difference of the speed.

While checking the-speed, the belt should be fully on tight pulley, and not very slack, the slippage of the belt should also be noted.

(3) Winder should not be delayed for want of bobbins or yarns, or repair work of the machine. They should also not be allowed to waste their time or come late.

(4) An efficiency book should be kept after the following style and watched daily and carefully.

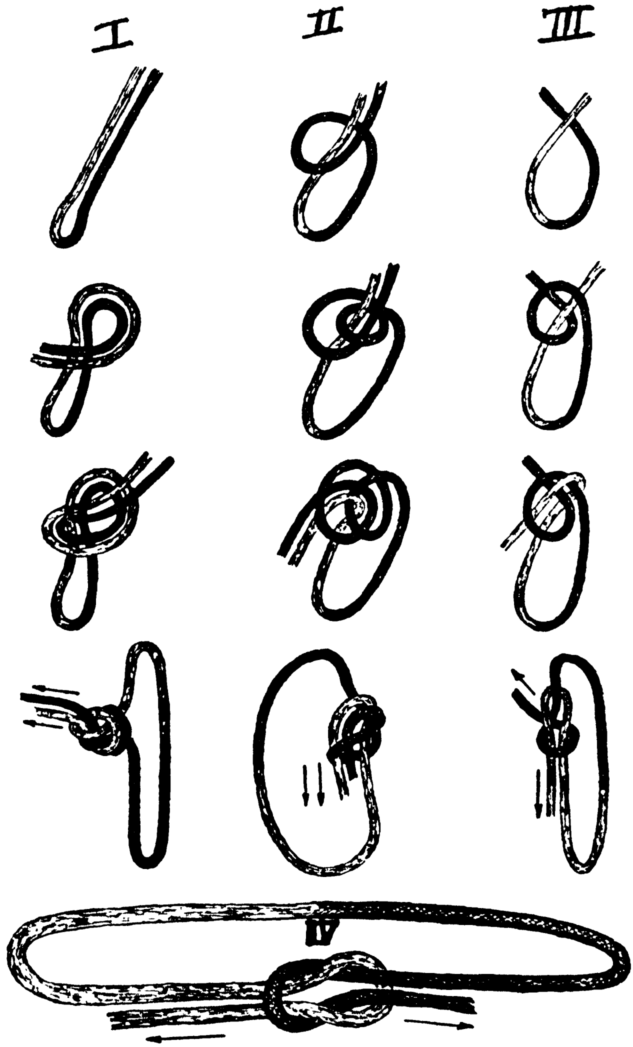
WINDERS' EFFICIENCY BOOK.

Date......................193

Winder No.	12			
Name				
Counts	20s			
Standard Prod; at 100%	140 lbs.			
Description	Prod:	Prod:	Prod:	Prod:

The winders pay sheet should thoroughly be checked with the issues of yarn from the spinning department that is the total amount of wages must tally with the total weight of yarn issued to the winders during the whole of the month.

KNOTS COMMONLY USED IN THE WEAVING INDUSTRY.



It should be assumed that the two ends of a piece of yarn are being united; consequently, in order to distinguish the two ends, one part of the piece of yarn is shown darker than the other. The arrows in the lower diagrams indicate the direction or directions of pull necessary to tighten the Knot.

I. is known as a "Dog-knot" and sometimes as the "Overhand loop." This type of yarn should not be used for thick or coarse or heavy yarns, though it is tied by several types of mechanical knotters used for tying fine yarns.

II. is known as the Winder's knot and is used extensively by winding operatives in several branches of the textile industry.

III. is a "Weavers Knot."

IV. is a "Reef Knot" nearly completed.

CALCULATIONS.

To Find R. P. M.

$$\frac{\text{R.P.M. of line shaft} \times \text{Dia. of drum on line shaft}}{\text{Diameter of driven pulley on machine}}$$

$$\frac{160 \times 10}{10} = 160 \text{ R.P.M.}$$

To Find Speed of Spindles—

$$\text{R.P.M.} = \frac{\text{Speed of driving pulley} \times \text{Dia. of tin roller}}{\text{Diameter of spindle wharfe}}$$

$$\frac{160 \times 6}{1.5} = 640 \text{ R.P.M.}$$

In ascertaining the speed of the spindle one point that should be noted in this connection is that the diameter of the band should be added to that of both the drum and whorl for accuracy.

To Find Yards per Minute (Empty Bobbin)—

$$\text{Y.P.M.} = \frac{\text{Diameter of barrel } \times 22 \times \text{ speed of spindles}}{36 \times 7}$$

$$= \frac{1.25 \times 22 \times 640}{36 \times 7} = 69.84 \text{ yds. per minute.}$$

To Find Yards per Minute (Full Bobbin)—

$$\text{Y.P.M.} = \frac{\text{Diameter of full bobbin } \times 22 \times \text{ speed of spindles}}{36 \times 7}$$

$$= \frac{3 \times 22 \times 640}{36 \times 7} = 167.62 \text{ yds. per minute.}$$

The rate of winding on a full bobbin is almost three times the rate of winding at the commencement, when winding on to the bare barrel.

To Find Production at 100 per cent.

Speed of Spindle = 720
Working hours = 9
Counts of Yarn = 20s

$$\frac{720}{1} \times \frac{66}{7} \times \frac{540}{840 \times 36 \times 20} = 6.06 \text{ lbs.}$$

To Find weight in grains.

$$\frac{7000 \times \text{length}}{840 \times \text{counts}} = \text{weight in grains.}$$

To Find Counts.

$$\frac{7000 \times \text{length}}{840 \times \text{weight in grains}} = \text{Counts.}$$

To Find Length in Yard.

$$\frac{840 \times \text{counts} \times \text{weight in grain}}{7000} = \text{Length in yard.}$$

To Find weight in Ounces.

$$\frac{16 \times \text{Length}}{840 \times \text{Counts.}} = \text{Weight in ounces.}$$

To Find weight in lb.

$$\frac{\text{Length}}{840 \times \text{Counts.}} = \text{Weight in lb.}$$

Drum Winding.

Drum winding is principally adopted either in single or double drums for coloured yarn which the manufacturer receives dyed, mercerised, etc., in the form of a hank, either two-fold or single yarn of various counts.

The hank is only a temporary form in which cotton yarn is wound for the various treatment it has to undergo, e.g., bleaching, dyeing, printing, and sizing, after which it is rewound into the form of bobbins according to the final purpose for which it is intended, whether to serve as warp or weft yarn.

The hanks are placed on swifts or ryces to wind from. In some mills upright spindle winders are used with single lines of spindles, but the drum winder gives more satisfactory results than the upright spindle winder. Much waste and inferior work is often caused by using seven lea reeled yarn as reeled for export market instead of crossed reeled yarn.

Where the coloured yarn is concerned, the quality of the yarn, the shade, the manner in which the hank has been reeled (whether straight or X reeled) are very essential to watch and examine daily.

The barrel-shaped bobbins allow more yarn to be put on the bobbin and is used for coarse yarn; the straight bobbin is favoured for fine yarn, as it gives greater uniformity of tension in unwinding. For finer yarns the bobbin would be lighter and have a larger barrel For cotton the usual dimensions would be 3½ in. diameter, flanges 4½ in. chase; 1¼ in. diameter, barrel, but 4½ in. flange and 6 in. traverse is more usual for coarser yarn.

Power = .66 I.H.P. per 50 drums.

Speed = 160 to 200 R.P.M., which should be regulated according to the diameters of the drums which vary from 9 to 10 inches and also according to counts and quality of the yarn being wound.

Production = A winder can do approximately 22 pounds of 20s per day of 9 hours, provided 12 drums are allotted to each winder. But a lot depends on the quality and fineness of the yarn.

$$\frac{\text{yds per min.} \times 60 \times \text{No of hours.}}{840} = \text{Hanks per drum.}$$

$$\frac{\text{Hanks per drum}}{\text{Actual counts.}} = \text{lbs per drum.}$$

Efficiency:—

Actual running time of machine = 85 to 88%.

Indirectly Needed Time:—

Preparing the hanks, each about	= 0.24 min.
Putting same on Swifts	= 0.40 min.
Exchange of full bobbins	= 0.19 min.

Loss Time:—

Attending thread breakages and finding end on the bobbin each	= 0.18 min.
Attending thread breakages and finding the end on swift	= 0.24 min.
Attending thread breakages and finding the ends on bobbins and swifts	= 0.32 min.
Attending to twisted hanks	= 0.10 min.
Walking between the single section parts and sundry stoppages	= 3 to 10%

Depreciation = 5% is ample.

Ratio of Drum to Looms—Depends on the nature and volume of work to be carried out in the loom shed. But the following may be taken as a guide.

180 R.P.M. = 2 Drums per Loom.
140 R.P.M. = 3 ,, ,, ,,

Waste = $\frac{1}{2}$ to 1 per cent depending on character and counts of yarn.

To Find the Speed—Multiply the diameter of the driving drum by the revolution of the shaft and divide by the driven pulley.

$$\frac{160 \times 12}{12} = 160 \text{ R.P.M.}$$

To Find Length delivered by one Drum per Minute in Yards—
Revolution × circumference of drum = inches per minute.

Inches per minute ÷ 36″ (in 1 yard) = yard per minute.

Revolutions = 160
Dia. of drum = 9″ × 3.1416 = 28.27 circumference

$$\frac{160 \times 28.27}{36} = 125.64 \text{ yards per minute.}$$

$$\frac{125.64 \times 600}{840 \times 20} = 4.48 \text{ lbs. per drum per day of 10 hours.}$$

Q.—The calculated surface speed of a drum winding machine is 120 yards per minute and the effected turn out is 70% assuming a winder is allotted a share of 18 per cent drums and that she is paid at the rate of $\frac{1}{4}$ of an anna per lb. Ascertain (*a*) the number of lbs. she can wind in a day of 8 hours of 20's counts; (*b*) the amount she would receive in wages in a month of 24 working days.

A.—(*a*) $$\frac{120 \times 70 \times 18 \times 60 \times 8 \times 1}{100 \times 1 \times 1 \times 840 \times 20} = \frac{216}{5} = 43 \text{ lbs. } 3.2 \text{ ozs.}$$

(*b*) $$\frac{216}{5} \times \frac{24}{1} \times \frac{3}{192} = \frac{81}{5} = \text{Rs. } 16\text{–}0\text{–}2.$$

Cheese and Cone Winding.

Considerable quantities of warp yarn, both grey and coloured, are now wound upon straight or conical paper or metal tubes, in such a manner that cheeses or cones with self-supporting sides are formed. The flanges required by ordinary warping bobbins are thus dispensed with, carriage is facilitated, and it becomes possible to bleach or dye the yarn without requiring it to be reeled and rewound. If the yarn has to be bleached or dyed, then the paper or metal tubes are perforated. Warping is also facilitated by the elimination of the bobbin momentum, and the excessive drag put upon the thread as the bobbins are emptied. Among machines of this type are the Split-drum winder, the self-contained Universal winder, and the Camless winder, each of which may be adapted to wind from the cop, ring bobbin, or hank.

Power =Up to 80 drums = 1 I.H.P.

Speed =300 R.P.M. (machine), 478 to 1078 R.P.M. of Drums

Production =Production per operative depends on the number of breakages and supply of bobbins that can be tied in a given time. But it may be taken from 125 to 280 yards per min, depending on the speed of the drum.

$$\frac{\text{yds. per min.} \times 60 \times \text{No of hrs.}}{840} = \text{Hanks per drum.}$$

$$\frac{\text{Hanks per drum}}{\text{Actual counts}} = \text{lbs. per drum.}$$

Depreciation = 5%

Schlaghorst M. High Speed Winder.

Power = 2.5 I.H.P.

Speed =640 R.P.M.

Production 14 lbs. per hour of 20s.

PIRN WINDING.

The Universal or Leesona winder for this purpose is chiefly used. This gives much better results than the old type of pirn winding machine.

Defects in Weft Pirns.

"Bad Knots"—These are a source of trouble when weaving off, because the yarn, as it is withdrawn from the pirn in the shuttle is liable to catch on the knot and break down.

"Ends not Pieced"—This fault is due to negligence on the part of the winder. Instead of joining the end on the pirn to the end on the hank or warper's bobbin, the latter is wound round the pirn. The result is a stoppage during weaving, and very often broken picks in the cloth.

"Placing the Hanks"–If the hanks are not opened out properly or if they are placed wrong on the ryces or bird–cages, the yarn becomes entangled during withdrawal, thus causing frequent breakages, waste, and loss of production.

Power = .28 I.H.P.
Speed = 610 (machine) R.P.M. and 2450 R.P.M. (Spindle)
Production = $1\frac{1}{8}$ lb. per hour of 26s.
Depreciation = 5% is ample.

To Find Production of Universal Winding.

Mean Dia. of Bobbin =13/16.
Speed of Spindles = 2350 R.P.M.

$$\frac{13}{16} \times \frac{22}{7} \times \frac{1}{36} \times 2350 = 166 \text{ yards per minute.}$$

$$\frac{1 \times 166}{840 \times 24} = .008 \text{ per spindle per minute.}$$

.008 × 540 Min. in 9 hours = 4.32 lbs. per Spindle of 24^{S} per day of 9 hours.

Q.—Find the production of a high speed winder each operator having 18 Spindles to mind. The efficiency being 80%. Ths working hours per day are nine. The delivery being 500 yards per minute and the counts of yarn 26s.

$$\text{A. } \frac{500 \times 60 \times 9 \times 18 \times 80}{26 \times 840 \times 100} = 179 \text{ lbs. practically.}$$

Vertical Spindles (Grey Winder).

Frame Date	Maker	No. of Frames	No. of Spindles	Speed of Line-shaft	Pulley Driver	Pulley Driven	Speed of Frame	Dia. of Tin Roller	Dia. of Wharfe F.	Dia. of Wharfe B.	Speed of Spindles F.	Speed of Spindles B.	Length of Belt	Remarks.
1930	R. T.	1	280	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	
		2	280	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	
		3	300	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	
		4	280	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	
		5	280	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	
		6	300	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	
	Total	6	1720	160	10	10	160	6″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	768	640	17′	

Departmental Particulars.

Counts.	Col. of Bobbin.	Bobbin. Lift.	Bobbin. Dia. of Barrel.	Flanges.	No. of Spindles allotted to each Winder.	Av. Production per Spindle per day of 9 hours.	Av. Waste %	Delivery in yards per minute.	Remarks.
22's	Red	5″	$1\frac{1}{4}$″	4″	28	5.88 lbs.		201.12	
30's	Green	5″	$1\frac{1}{4}$″	$3\frac{1}{2}$″	28	4.26 ,,	.27 lbs.	198.66	
40's	Yellow	5″	$1\frac{1}{4}$″	$3\frac{1}{4}$″	28	3.24 ,,		201.04	
50's	Blue	5″	$1\frac{1}{4}$″	3″	28	2.59 ,,		200.90	

Hands Employed (Grey Winding).

Designation.	No. of Hands.	Amount. Rs.	as.	Per.	Rate per 100 pounds Counts. 16	22	30	40	50	60	Remarks.
*Clerk ..	1	22	0	M.							*Receives and issues grey and coloured yarn.
†Jobber ..	1	42	0	,,							
Scale Coolie	1	16	0	,,	As. 9	As. 13	As. $15\frac{1}{4}$	As. 18	As. 20	As. 22	†Attending to cop winding, warping & universal winding.
Winders ..	60	piece work									

Stores Consumed (Grey Winding).

Description.	Quality. No.	Weight.	Per.	ReTarks.
Spindle Oil		7 lbs.	Week.	A mixture of $\frac{2}{3}$ spindle and $\frac{1}{3}$ castor oil is more advantageous.
Brooms	20		Month.	
Laces		$\frac{1}{4}$ lb.	,,	
Tubular Banding ..		2 ,,	Week.	
Emery Paper ..	12		M	
Chalk		2 ,,	M	

Drum Winding

Date.	Maker.	No. of Frame.	No. of Drum.	Speed of Line Shaft.	Pulleys.		Speed of Frame.	Dia. of Drum.	Length of Belt.	Remarks.
					Driver	Driven.				
1930	R.T.	1	50	160	12	12	160	9″	17″	
		2	50	160	12	12	160	9″	17′	
		3	50	160	12	12	160	9″	17″	

Departmental Particulars.

Counts.	Col. of Bobbin.	Bobbin.			No. of Drums allotted to each Winder.	Av. Prod. per Spindle per day of 9 hours 100%.	Delivery in yards per min. per Drum.	Waste %	Remarks.
		Lift.	Dia.	Flange.					
18's	Red	5″	$1\frac{1}{4}$″	$3\frac{1}{2}$″	10	4.47	125.64	1	
20's	Blue	5″	$1\frac{1}{4}$″	$3\frac{1}{2}$″	10	4.04		1	
2/40's	Green	5″	$1\frac{1}{4}$″	$3\frac{1}{2}$″	10	4.04		.64	
2/60's	Black	5″	$1\frac{1}{4}$″	3″	10	2.70		.64	
2/80's	Violet	5″	$1\frac{1}{4}$″	3″	10	2.02		.64	

Hands Employed (Drum Winding).

Designation.	No. of Hands.	Amount.		Per.	Rate in annas per 10 Pounds Counts.							Remarks.
		Rs	as.		16	20	24	40	2/40	2/60	3/32	
Coolie	1	16	8	M.	6	7	8	12	8	9	5	Waste must not be allowed to exceed as given in the preceding table.
Winders	30	piece work										

Stores Consumed.

Description.	Quantity.		Per.	Remarks.
	No.	lbs.		
Spindle Oil		2	Week.	A mixture of 2/3 spindle oil and 1/3 castor oil is more advantageous.
Broom	10		Month.	

Universal Winding (Leesona).

No. of Frames.	No. of Spindle in a Frame	Speed of Line Shaft.	Pulleys.		Speed of Frame	Pulleys on Frame		Speed of Spindle.	Length of Belt.	Remarks.
			Driver.	Driven.		Driver.	Driven.			
26	20	200	30	10	600	8	2	2400	24′ ft. of 2½″	

Departmental Particulars.

Counts.	No. of Spindles Allotted to each Winder.	Average per Spindles per day of 9 hours.	Average Waste %	
2/16's	10	13·34	.20	
20's		5·33		
24's		4·32		
20's		2.67		

Hands Employed (Universal Winding).

Designation.	No. of Hands.	Amount.		Per.	Remarks.
		Rs.	as.		
Winders ..	52	17		Month.	Same Mistry, that looks after winding and warping, looks after this department too.
Fitter	1	30			
Coolie	1	16	8		

Stores Consumed.

Description.	Quantity.		Per.	Remarks.
	No.	lbs.		
Velocity oil	Tins. 6		Month.	
Brooms ..	10		,,	

CHAPTER XXV.

BEAMING MACHINE.

The Importance of Warping Machine.

Warping is of a paramount importance. Any carelessness at this stage will prove a hinderance and annoyance to the weaver beside retarding the progress of outturn in the subsequent operations, and also tend to develop faults of a serious character in cloth produced from it.

Methods of Warping.

There are several methods of preparing the warp yarn. These include (1) Ball Warping, (2) Cross Warping, (3) Sectional Warping, (4) Chain Warping.

Operation of Warping.

The operation of warping consists of withdrawing and gathering together any practicable number of ends simultaneously from a corresponding number of warper's bobbins in order to obtain a series of parallel threads or ends of uniform tension and length on to a back or slasher's beams, each containing a measure of the total number of ends (say 2,000) required on one weaver's beam, and with the same length of warp on all beams constituting the same set.

The length of warp, however, contained in warper's beams may vary from two to any number of times greater than that usually wound upon a weaver's beam, according to the counts of yarn, number of threads wound upon each warper's beam, diameters of the respective beam flanges, and other variable factors.

The general idea is to aim at filling the beams just short of being level with the outside edge of the flange. A beam 54 inches between the flanges, with a 4½ - inch barrel and flanges 21 inches in diameter, will hold about 250 pounds of yarn, medium counts, without being too full or pressed too hard.

All the warping is done on the beam warping machine of the standard 9/8's type friction driven, hairpin stop motion, falling rollers, wrap and dial measuring motions with a creel for 504 bobbins and perhaps one or more creel up to 600 bobbins and one or more

creel for about 200 bobbins whih serve the purpose of preparing an independent coloured beam for borders (*Dhoties*). The general length warped of various counts is as follows :—

12's	grey	= 6,000	yds.
14's	,,	= 7,000	,,
16's	,,	= 8,000	,,
20's	,,	=10,500	,,
26's	,,	=12,000	,,
36's	,,	=18,000	,,
40's	,,	=20,000	,,

The driving part of a Beam Warping Machine consists of a frictional cone clutch mounted on one end of a shaft on which there is also mounted a large wooden drum to turn the warper's beam. The machine is worked by pressing the foot board and thereby pressing the free pulley outward until it grips the tapered rim of the disc with sufficient frictional resistence to drive the drum and turn the warper's beam. A heavier counter weight is attached to one of the arms of the foot board to counter balance it. On the driving side a short pin projects and freely enters into a long slot of the curved lever which can oscilate on the drum shaft. The rear end of this curved lever is connected with the lower end of trigger rod on the top of which there is a bow spring. An adjustable comb to regulate the width of the warp exactly with the width between the two flnages of the beam. The dents of this comb are made half-round to lessen the frictional resistance and also kept bent to ensure through or correct position and the turning of the threads always in the same direction. The back beams are retained in position on the drum by means of radial arms, which are known as Beam Evener and Retaining Device. The beam simply remains in contact with the drum by gravitation only. These arms allow free vertical movement but not lateral. The beam instead of revolvlng steadily very often revolves with a more or less bumping or jerky motion which is a sure indication of variation in the counts of yarn. When this happens the yarn evener device keeps the warper's beam under better control during the process of warping. Some warping machines are provided with expanding, driving drums which are capable of adjustment to fit the various width between the flanges of the warper's beam.

Behind the front comb there is a grid table which is known as Singleton's automatic thread breaking stop device and over which, the expanded sheet of threads travel. Each thread supports a

light wire drop pin bent in the form of staple hook $1\frac{3}{4}''$ long. It hangs freely above each thread between the bars of the grid which prevent the drop pin being carried forward by the progress of the yarn. Beneath this grid there are two smooth iron rollers which revolve invariably. These rollers get their motion from the drum shaft through a short, vertical shaft and bevel gearing. There is a ratchet clutch arrangement in the driven bevel wheel on the inclined shaft by which this shaft can revolve together or else become stationary. The object of this clutch device is to put the two iron rollers out of action while unwinding the yarn from the beam to recover the lost end of the broken thread for piecing.

The Brakes are adopted to work side by side with the driving gear. Owing to the automatic stop device the machine stops instantly but the severed end goes on with the momentum of the beam to avoid this, brakes are introduced to stop the machine.

Two light tin falling rollers which are known as Tension rollers rest in the vertical slots of the framing and upon the sheet of threads. These rollers descend freely when the beam ceases to revolve and thereby preventing the warp threads to become slack and entangled due to bobbins continuing to revolve for a little longer time. Again the warper has to turn the beam round by hand until the drop rollers come up and then the warper starts the machine by pressing the foot board

Foot board mounted with weight oscilating on drum shaft, to which is hinged the lower end of the trigger rod, to ascend. The depression of the foot board raises the balance weight and causes the trigger rod to ascend until it hooks on to the retaining ledge of the bracket.

A tin measuring roller which is 18″ in circumference is worked by the frictional contact of yarn. There is a worm at the end of the measuring roller that drives a worm wheel on a short shaft, on the outer end of the short shaft there is another worm which drive a worm wheel having a small scroll disc with spiral groove to receive the free pointed end of lever.

Creeling.

The creeling of the bobbins is done either by winders or creel boys. In the case of the former, the mills pay nothing extra for creeling and in the case of the latter, the mills pay to the boys.

The work done during the creeling of, say, 400 bobbins is roughly 1,280 foot-pounds per hour. This is based on creeling 400 bobbins, each weighing one pound, in about 60 to 75 minutes, and raising them half the height of an 8-foot creel. It must also be remembered that this 1280 foot-pounds of work is performed under very difficult conditions, as the operative is inside the V creel in a somewhat cramped position, owing to the presence of skips, etc. and hence the creelers must be strong and active if maximum efficiency of the process is to be obtained. The creelers must be paid very reasonably.

Starting a beam

After the creeling of the bobbins the weaving master should insist on each end having a drop-wire on. Another important point on starting a beam, in addition to tension and weighting, is to see that the reed raddle distributes the ends equally, and flush with the flanges on each side.

Production varies

The relative productiveness of a beam-warping machine varies within a very wide range according to speed, counts of yarn, number of threads warped and ability of the warper. The product of a warping machine on an average of 20 counts should be about 24,000 yards per day of 10 hours, but bear in mind that the outturn depends a great deal on the quality of the yarn etc.

Production of high speed warping machine

But on a high speed warping machine 1,00,000 yards can be got per frame per day of ten hours, provided the quality of yarn is good and a skilled operative is looking after it.

Half bobbins should be emptied periodically

The yarn is again finer when it leaves the warping frame than it is on the winder's bobbins, owing to stretch which varies according to the cotton mixing particularly due to the blending of staples of cotton, such as mixing short staples with long staples, etc. There is generally some yarn left on the warper's bobbin warping off the unusual length, and hence this yarn is likely to go soft and dirty if allowed to stand for a long time. It is therefore advisable to turn as nearly empty as possible what is called the half bobbins periodically either for making a sample or finishing the balance of an order.

Allowance should be made for seconds

It is necessary to warp 1% over and above the existing order to compensate for seconds and fents. An important point to obeserve is that all the machines should, if possible, be of one make, in order that they may register exactly the same length of yarn, and thereby prevent waste with each set of beams when finished in the sizing frame. Should any inaccuracy or difference exist between the register of these machines, one beam will be finished before the remainder of the set, or will contain a quantity of yarn when the others are finished, in either case entailing the necessity of pulling all the yarn off the beams remaining after the first has been finished, and throwing it into the waste bag. It frequently happens that several pounds of yarn are lost in this manner which could easily be prevented if proper means were taken. In an establishment which accepts small orders of cloth, and makes many varietires or several patterns in each quality particularly *Dhoty* borders, great difficulty is often experienced in making the exact quantities besides the loss in production. The result is that either too many or an insufficient number of pieces are made, but mostly the former. As merchants generally refuse to take these made over the order, a great quantity of odd lots accumulate on the hands of the manufacturer, which have to be sold at a considerable sacrifice as "job lots." It will be obvious that the loss accruing upon these remnants or orders plus waste obtained from the warper's beams and the process of sizing go to diminish the amount of profit upon the original one; with proper instructions and careful management there ought to be no difficulty in minimising the waste as well as the odd prices which by arrangement with selling agent may be packed in the last bale of each quality that remain to be delivered.

The result of an oversight

The writer once in his experience saw in a large weaving mill where 4 out of 15 warping frames were working for about 15 years with incorrect lengths and thus tons of money were lost by way of waste, and yet several people that were in charge of that department could not lay their hands on the fault which was nothing else but a mere oversight on the part of the makers of the machines who supplied them with 110 finger wheel instead of 100 teeth and hence when it was required to warp 15000 yards the warpers were instructed to do 18600 yards after making several trials with the length with some loss.

Common Faults

Common faults found in warping are dirty yarn, broken yarn, stained yarn crooked barrels, barrels not round, barrels unequal in diameters, barrel rough and splintered, bent or crooked flanges, flanges rough inside, cracked or snipped flanges, loose flanges, bent pikes, loose pikes, worn pikes, creel defects, defective wraiths, effect of unsteady drive, defects in driving drum, drop rollers, pin grid, and stop motion, pressure on beams, lost ends, crossed ends, big knots, snarls, and mixed counts of yarn.

Constant attention must be paid to avoid the above faults.

A very ready means of ascertaining the presence of mixed yarn on a beam while in process is to run the hand along the beam surface. Ridges or hollows indicate irregular counts or irregular denting, etc. Still better stop the frame., and then pass your eyes across the sheet of ends and you will very likely find five out of ten frames running at least with few bobbins of mixed counts owing to slack supervision in the winding department, carelessness during weighing the yarn in the spinning department, and during the transit of yarn between spinning and weaving departments. All beams on the outside of the flange should be painted with a serial number and tare weight of the beam. Each time a beam is wound with yarn, it must be weighed and particulars put down on a ticket which should be posted on the outside of the flange for further reference and record. But should there be an old ticket already pasted on the flange, it should be removed before pasting a new one.

The velocity of the frictional winding drum may range from 40 to 50 revolutions per minute, according to counts of yarn.

Index Number.

Index of machine	9/8's	6/4's	7/4's	8/4's	9/4's	10/4's	A 9/8's machine will take a warper's beam 65" from outsdie to outside of collar, such a beam is 61½" on the wood and the latter 4⅜" in dia. when empty.
Width of drum	54"	60"	66"	72"	78"	84"	
Reed space of Loom.	52"	58"	64"	70"	76"	82"	

Drag must be reduced to a minimum

What might be a good principle in respect of winding and unwinding at the beaming frames would not occur to the unobserving mind of people in charge, until an excess of damage and loss forced itself on the mind. In the bulk of mills, especially the old ones, there are bobbins worn down by usage. The banging of the bobbin by the winder on the spindles at one end leaves an oblong creel peg hole, and there is also the worn down creel peg in the middle and ends. The bobbin has been iron-hooped at the edges of the flanges, and what happens is this. The bobbin in its revolutions sets up vibration in the thread by its eccentricities, and with the over-weighted bobbin in addition, the warper experiences much difficulty and breakages in making a start with the beam. It is always a worry to a weaving master what to do when he receives a complaint of the material working badly in the winding frame. But he is completely at a loss what to do if the yarn is winding fairly well and warping badly. He would like to put more drag on in the winding, but finds there is no mechanism for the purpose without very extensive alterations, and increase in cost of production in addition to demanding extra attention from operatives and executives who usually have sufficient on their hands and minds in coping with the ordinary routine of production. He is compelled to pacify the work people by saying he will take the matter up with the spinner. If he would take a salter's dram spring balance and attach it to the yarn between the traverse and drag board, it would indicate the drag. If it registers under four drams it is too little, if over eight drams it is too much. Follow a bobbin of yarn 5 in. lift × 3 in. flanges holding 21,000 yards of 40's counts to the upright V-creel in the warping frame, where there are fixed glass steps and upright glass rods—as an ideal condition—the drag is three and half drams. The same bobbin with wood steps and iron upright rods the drag is six drams.

It is a known fact that drag should be reduced to a minimum in the warping frame. The idea of extracting weak places from the yarn in the warping frame is a mistake. Besides, it is absolutely impossible to remedy defects in preparation and spinning that leave unsightly slubs, or badly-made knots in the yarns, and the only effective way of utilising yarns that possess inferior qualities of the above nature is either to combine two or more such yarns to form a twist or folded yarn and use it for some other purpose, or to make use of the faulty yarn as weft in the manufacture of an inferior grade of cloth or in a coarser kind of cloth.

Quality of warp must be maintained

It need hardly be said that the production obtained from any weaving department is influenced to an enormous extent by the quality of the warp and weft yarns, and also—but perhaps to a lesser degree—by the combined efficiency of the various operations conducted between the time of arrival of the warp and weft yarns from the spinning department and the time that the two kinds of yarn are ready for being combined in the textile fabric by the usual operation of weaving.

In many cases, it is impossible to deal effectively and satisfactorily with badly-prepared or inferior yarns, especially warp yarns. Everything that is bad which escapes on the bobbin should be allowed in reason to run off on the beam, if that beam is to run off well in the sizing machine. This may sound erroneous, but the reasons are that the disease is less destructiove than its eradication Why ? Because good beaming or warping depends on constant running, as when stoppages are made and the turning back of the yarn is necessary to find a lump of weak place, the yarn always gets out of its groove when re-wound. It is these out of the groove threads that play so much havoc in making lappers in the unwinding at the sizing machine, unless the warper is an expert.

Average breakage

The average breakage in the yarn should not be under 200 to 400 yards. If it is under 100 yards serious attention must be devoted to find the reason of excess brekages and the remedy for same.

Adjustment of speed

The adjustment of speed in the warping frame plays an important part. If the outfit consists of large heavy bobbins with wood steps and iron guide rods, the speed should be about 65 yards per minute only. But if the bobbins are of the exact size, and hold just the length to fill the beam, and are placed in the creel with glass steps and glass guide rods, the machine may be run 75 to 80 yards per minute with fewer breakage in the yarn. The system in vogue at some places, where they creel with large full bobbins in some parts of the creel, while other bobbins are three parts full or even only half or even quarter full, must strongly be condemned. Because the difference of tension on each thread is great and it follows that the unwinding of the threads varies accordingly. In many instances the consequence will be found to be, if the beams are followed, the yarn coming off slack in places.

Evenness of frame driving

Another important item is evenness of frame driving. If the balancing roller is kept constantly on the move, upwards and downwards, due to vibration, and occassionally goes bang at the top of the slot, thus setting the drop pins dancing. Through this twitching and tugging of the threads, the weak places are found and they break down, otherwise they would escape. Electrical driving is ideal for warping frames to overcome this drawback.

Again, the measuring and carrying rollers, along with the front and back expansion combs, should be made as smooth as possible, and well balanced. Great care should be exercised to prevent acqueous vapours or steam rusting these combs or rollers, as the warper cannot get the thread to draw from the bobbin for piecing-up purposes without breaking through this rust, which chafes the yarn. It pleases the eye very much to see carrying rollers and bearings painted and enamelled, but when the eye betrays the practical, then it is best to abandon the appearance, rub off the paint and polish up the bearings and rollers until they are as smooth as glass. Why keep the green baize cloth on to accumulate fluff for the slack ends to pick up when turning back, or to lock and break down the ends at the stopping pins. It is far better to let the fluff drop through to the floor than to lose production and often times cause irreparable damage.

Care is taken to keep the cast and malleable iron flanges straight and painted, but how much the sizer and weaver suffer when this is neglected. A crooked or rusty flange causes a few ends at the side to rope or tape together, which afterwards must be wasted at the expense of the cloth being narrow when woven. The enamelled and light steel flanges without holes are the best, as they give a better balance in the unwinding—so much desired by the sizer.

What a blessing it would be to the sizer and warper if all the beams were made as true as if they had been turned upon a lathe.

Faults to look for

Large knots—The operative is ofen careless in making large knots with the result they get entangled with the other ends and break them whilst passing through the sizing machine.

"*Missing Ends.*"—The worker is at fault, for, instead of turning the beam back and finding the broken thread and piecing it up correctly, he simply puts the thread in without tying. This broken thread will run round the beam in the sizing frame and will have to

be cut off at some later period. More often than not several other threads are cut at the same time. When this gets to the loom there are one or more missing threads for several yards and consequently the weaver has to cross over threads from the side to make up the deficiency.

" *Crossed Ends*"—These crossed ends occur through the carelessness of the operative who fails to see whether the end is straight before tying up. When crossed, the end invariably breaks during sizing and often breaks the adjacent ones at either side. They are missing for some yards and again the weaver has the trouble through no fault of his own.

" *Soft Beams* "—This fault causes one or more ends to sink amongst the other yarn and during unwinding are apt to break at the sizing.

" *Bad Sides* "—Very often these are due to the beam flanges being in bad condition or incorrectly placed on the barrel. Also the operative fails to see that the threads are either too close or too far away from the flanges. In any case it will result in the ends at the side breaking in the sizing.

CALCULATIONS.

$$\text{Length} = \frac{\text{Nett weight of yarn} \times \text{counts} \times 840}{\text{number of ends}}$$

$$\text{Ends} = \frac{\text{Nett weight of yarn} \times \text{counts} \times 840}{\text{length in yards}}$$

$$\text{Counts} = \frac{\text{Length in yards} \times \text{number of ends}}{\text{nett weight of yarn} \times 840}$$

$$\text{Weight} = \frac{\text{Number of ends} \times \text{length in yards}}{840 \times \text{counts}}$$

$$\text{Total Hanks} = \frac{\text{Ends} \times \text{Length}}{840}$$

Hanks $\div$ counts = weight.

Hanks $\div$ weight = counts.

To find the approximate weight of yarn of any counts that may contain on a warper's beam.

EXAMPLE :—

The weight of yarn on a full beam 54 inches wide with a barrel 6 inches diameter and flanges 21 inches in diameter is approximately as follows :—

$$\frac{(21-6)^2 \times 0.7854 \times 54}{60} = 280 \text{ lbs.}$$

To Find the Speed of Frame.

Speed of line shaft =80
Dia. of drum = $8\frac{1}{2}''$
Pulley on frame = $14\frac{1}{2}''$

$$\frac{80 \times 8.5}{14.5} = 46.89 \text{ speed of frame.}$$

To Find Yards per Minute—

Circumference of drum =62″
Speed of frame =46.89

$$\frac{\text{Rev.} \times \text{cir.}}{36} = \frac{46.89 \times 62}{36} = 80.75 \text{ yards per minute.}$$

80.75×60 (min. in 1 hour) $\times 10$ (hours per day) = 48,450 yards per day.

Power.

The power required to drive a beam warping machine is estimated to be $\frac{1}{3}$ to $\frac{1}{2}$ I.H.P. according to size of machine and number of threads warped simultaneously.

Speed =30 to 50 R.P.M.

The speed of the drum varies according to the counts and class of yarn, but in most cases it is run at about 48 R.P.M.. It is a false economy to run the frame too quickly, because, in addition to more ends breaking down, the greater momentum causes more yarn to be wound on after the stop-motion has acted, with the result that the broken end is not easy to find.

"Production" =400 to 500 lbs. per frame per day of 9 hours av. counts =20s.

In order to obtain the maximum outturn, it is necessary for the management to watch the efficiency of this department daily and they should acquaint themselves with the following particulars :—

1. Whether the yarn is working satisfactorily or not. If not how often they are breaking, that is, at what lengths do the breakages occur, which should be recorded and compared with former breakages.
2. The speed should be watched, the belt examined for slippage etc.
3. Warpers should not be delayed for want of bobbins, empty rolls, creeling and repair works. The creel must be kept in perfect condition with regard to its being perfectly straight. The creel steps and pegs should be examined periodically.
4. At the end of each month the pay sheet of the warpers (that are paid by the piece) should be very carefully checked (1) by the departmental chief clerk (2) Head clerk (3) head of the pay office or time-keeper, with the quantity of yarn issued to them from the winding department. Some of the clerks that have been found overpowered by temptation have practised dishonest means by adding 2 or 3 lbs more per beam over and above the actual weight.

Ratio of Warping Machine to Looms.

The ratio varies considerably as it depends on the speed of the machine and the looms, the counts of yarn employed, and other variable factors. With average speeds, counts and particularly quality of yarn, an estimate of one warping machine for about 90 looms for plain goods but if there are coloured goods such as shirtings *Dhoty* borders, etc., then 65/70 looms may be taken for a general base.

Depreciation.

The allowance for depreciation, including the cost of oil, repairs, renewal of wires drop pins for the automatic thread stop motion, renewal creel pegs and the application of modern improvements will probably be about 6% per annum.

EFFICIENCY.

General time.

Pure running time of machine, 85% to 88%.

Indirectly needed time.

Exchange of bobbins, each 0.40 min.

Lost time.

Attending easy thread breakages, 0.60 min.

Attending complicated thread breakages; turning back drum, 1.3 to 2 min.

Removing entanglements, 0.15 min.

Repairs—depends on nature and facilities

Fetching the jobber, 0.8—1 min.

Other Stoppages—loitering or smoking etc. outside in the compound.

STORAGE OF BEAMS.

Back beams should be carefully stacked. The best method is to wrap each back beam in sacking particularly if it is a coloured beam. To avoid broken ends in handling, either in receiving or loading, pulley blocks and runways should be provided, using plenty of packing in the case of loading from mill to mill.

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Warper's Efficiency Book.

Warper No.	12	13	14	REMARKS.
Name				
Counts	20's	40's	20's	
Length				
Standard Prod. 100%				
Description	Weight	Weight	Weight	

Machinery Data.

Width of machine.	Maker & Date.		No. of Frame.	Size of Creel.	Dia. of Drum	Speed of Line Shaft.	Pulleys.		Seed of Frame.	Av. Length of Belt.	Remarks.
	M.	D.					Driver.	Driven.			
9/8's	R.T.	1930	16	512	19¾	80	8½"	14½"	46.89	25'	Interchangeable Drum for Dhoty Border Length =21"/22"

*Hands Employed.

Designation.	No. of Hands	Amount. Rs. A. P.	Per.	Rate. As. p.	Per.	REMARKS.
Warpers	16	piece work		3 2	700 yds. × 100 ends	Each.
Creelers	5	16 8 0	M.			
Sweeper	1	8 0 0	M.			Also sweeps the winding department.

*Stores Consumed.

Description.	QUANTITY. No.	QUANTITY. lb.	Per.	REMARKS.
Oil				Very little included in the consumption of winding department.
Warper's drop pin creel pegs .. .. .. Warper's bobbins				According to consumption or demand which must be watched very carefully.

***Details of Hands employed and stores consumed are given here by way of a guide and information.**

Dimension of the Room.

Grey, Colour and Universal Winding and Warping Department.

Size of Room.			Door.		Windows.		Skylights.		Remarks.
L.	B.	H.	No.	Size.	No.	Size.	No.	Size.	
120′	100′	12½′	1	7′-6″ × 4′-3″	8	9′-0″ × 5′-6″	10	10′×10′	Skylights, square in shape, which are adopted in the case of terrace roof, otherwise saw-tooth shape, which are built in such a manner as to get the north light.

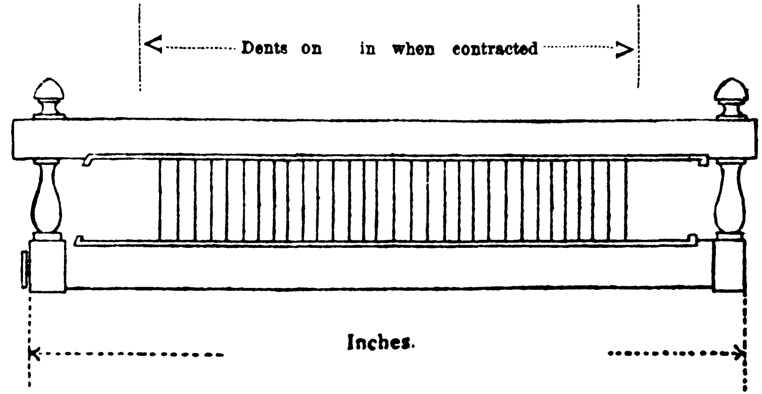
BACK EXPANDING COMB SPECIFICATION FOR BEAMING FRAME

How many Back Combs? ....

How many dents in each?

What is the least space
they must occupy thus :—
when contracted? ....

What is the length over
all? ....



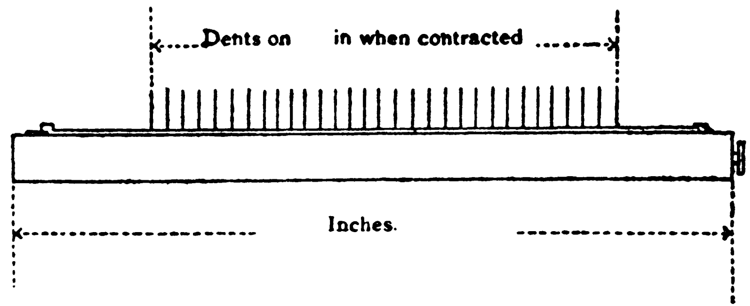
FRONT EXPANDING COMB SPECIFICATION FOR BEAMING FRAME

How many Front Combs? ....

How many dents in each?

What is the least space
they must occupy thus :—
when contracted? ....

What is the length over
all? ....



FRONT EXPANDING ZIG ZAG COMBS SPECIFICATION FOR BEAMING FRAME.

How many Front Combs? ....

How many dents in each? ....

What is the least space they must occupy when contracted? ....INCHES..........................

What is the length over all? ....

CHAPTER XXVI.

SIZING.

Sizing commenced originally in the early days of cotton manufacture in India, but of the actual date when it was first found desirable to pass cotton threads through rice water, in order to assist in the weaving of the fabric, there is no record.

Dating from that period, constant additions to, and many improvements in, the important process of sizing have been made.

Hornby and Neuworthy invented the "tape machine" in 1839.

Sizing began in necessity due to the fact that yarn as received from the spinners has a rough, hairy appearance, and hence unfit for the friction of weaving. But it has ended in something like dishonesty to suit the market or meet the demand of the dealers where it is manufactured or exported to.

The point of absolutely perfect sizing has not yet reached, but science has done so much for all branches of industry in the past that it is only reasonable to suppose that it will be able to do more in the future, and in this advance sizing will share.

Slasher sizing, also known as tape sizing, is the most important of all processes in the preparation of yarn for weaving and is still carried out in good many mills with a strict measure of secrecy. There are many sizing or weaving masters or weaving managers who believe their own size mixings have advantages over others.

Sizing was, and is still is, largely empirical, many wonderful mixings having been made or tried and even patented, which in many cases have proved to be more or less useless.

The actual work is not difficult, but skill is essential in order to give just the right treatment to each set of beams.

The most responsible duty is that of mixing the size, after its composition has been decided on, and consequently this duty is usually undertaken or directed by a responsible officer.

Sizing is a process of impregnating the yarn with a preparation known as size mixing usually composed of flour or starch, in combination with various other ingredients, of an oily, a mineral, and a chemical character respectively.

Primary object of Sizing.

The primary object of sizing is to make the yarn smoother and stronger by laying down the protruding fibres (what is variously described as 'oozy', 'fluffy' and 'hairy' yarn), from the main body of the threads, thereby enabling them to resist more effectually the tensile strain and abrasive friction to which they are subjected, chiefly by the chafing action of the shedding harness or healds, and also by the reed and shuttle raceboard during weaving without reducing its elasticity, pliability, cleanliness or colour.

Yarn Tension must be Regulated.

Careful consideration should be given to the yarn tension between the various points in the tape sizing machine. Extensive tension at any of the three following important places will result in hard brittle yarns that will have a low breaking load and extension. Such yarns are bound to give considerable weaving difficulties. The back beams in the sizing creels should not have more tension than what they had during the process of warping. To apply more tension is to render the yarn liable to break, during the process of sizing, in which the yarn is necessarily stretched to the extent of about one per cent between the squeezing roller and drawing roller. Out of an extensibility of about 5 per cent the ordinary yarn possesses, undoubtedly about 2 per cent is lost in winding, warping and sizing; the remainder should be carefully preserved for weaving, where elasticity is very essential.

(1) Between beams and nip of sizing rollers,
(2) Between sizing rollers and drag rollers,
(3) Between drag roller and weaver's beam.

An inefficient or indifferent sizer may easily upset the working of the entire weaving department of a mill. On the other hand, a capable sizer will so regulate the application of the size, and the drying after sizing, that the beams produced will pass through the process of weaving with a minimum of trouble, and produce the desired weight, feel and texture of cloth. To acquire this standard of efficiency in tape sizing, experience must be combined with a thorough knowledge of the theory of sizing. The functions of sizing, drying, and beaming, as well as those of cooling and separating the threads, measuring the length of warp and of marking it into cut-lengths, and pressing the yarn compactly on to the weaver's beam, are all performed concurrently by the same sizing machine.

Other objects sought are to impart to the finished cloth a certain characteristic feel, whether harsh or soft, familiar to experienced person who is really responsible to meet the demand as may be

required by the various dealers or markets, also to give it a finish that will impart on the cloth the appearance of better or superior quality and also to increase the weight artificially over 100%.

The slasher sizer is universally adopted in India. The drying of yarn is effected by passing it partially around and in direct surface contact with 2 cylinders heated with low pressure steam. The diameters of the cylinders are 6 or 7 feet and 4 feet respectively. The three principal parts of a sizing machine are :—

(1) The sow-box forming the rear part of the machine ;

(2) The steam drying cylinders and cooling fans in the centre;

(3) The head stock forming the fore-part of the machine.

There is also an auxiliary part consisting of a beam creel or stand situated immediately behind the sow-box, for the purpose of supporting the back beams containing the yarn to be sized.

The yarn is withdrawn simultaneously from all the back beams over the guide rollers and immersed immediately by means of the submerged copper immersion roller, into the solution of boiling size contained in the sow or size-box. On emerging from the size, the yarn passes between two successive pairs of sizing and squeezing rollers which serve the threefold functions of—

(*a*) Withdrawing the yarn from the back beams ;

(*b*) Compressing or imbedding the size into the yarn; and

(*c*) Expelling or removing surplus size from the yarn.

From the sow-box the yarn passes to the cylinders, but in order to keep it under the influence of these drying cylinders as long as possible, it is carried in a circuitous path, first to the large cylinder and then to the small cylinder passing partly around both. In this manner about 50 feet of warp is under the influence of the drying arrangement at one time. From the cylinder the yarn passes under the cooling fans and partly around the guide rollers.

The warp threads are then sub-divided into such number of separate sheet of threads as correspond with the number of back beams constituting the set from which the respective sheets of threads are withdrawn. This sub-division of the threads is effected by means of a corresponding number, less one, of iron rods or bars placed horizontally across the machine and fixed at regular intervals of about 12 to 18 inches apart, immediately above the framing of the headstock. The function of these rods is to keep the respective

sheets of threads from the several back beams separate and distinct from each other, and thereby facilitate the recovery of broken and missing warp threads. They also serve incidentally to effect a separation of threads that may have been sized and dried in contact with others, and therefore cling together.

On leaving the dividing or split rods the yarn passes in groups of several threads between the dents of an adjustable half-reed or comb, which may be expanded or contracted to regulate the width of warp exactly to the distance between the flanges of the weaver's beam.

From the half-reed the yarn passes partially around a tension of delivery roller by which the yarn is withdrawn forward from the point at which it emerges from the second pair of sizing rollers, and from which it is also delivered to be wound finally on to the weaver's beam, ready for drawing-in and then weaving.

The General Duties of a Sizer are as follows:—

CREELING.

Removing the empty section beams from the creel and replacing full ones. If two widths of beams are used in the same creel then the narrower ones should be placed farther away from the machine, so that the sheet of ends would be carried between the broader sheet of other beams. In case one beam out of the set is all coloured yarn or a stripped beam it should always be warped on the widest beam so as to come nearest the machine.

If a full back beam is built up soft at one or both sides it is placed at the rear of the creel, so that the broken ends will not be taken forward. If placed in the front, the greater number of ends at that point might cause broken ends to be caught up and taken forward upright, and hence supports consisting of stout wire fixed into square wooden blocks are used to guide the edge yarn inside the beam flange, as, for instance, when the edge yarns tend to run outside the flanges.

When the beams leave the warping frame, the length of yarn number of ends, counts of yarn and the warper's number are written on the face of the yarn in blue or red crayon. Besides writing the particulars on the face of the yarn, they are also written on a ticket and pasted on the outside of the flange. This prevents the risk of accidentally putting in a wrong warper's beam. The particulars are also entered by the clerk after checking the beams in the tape book for future reference.

Back Sizer's Duties.

Before creeling takes place the back sizer should clean the machine and remove all waste. Before the set is infinished the sizer should always have the required number of beams for the next set ready at hand so that he will not have to lose much time after the set is finished but start at once with the next set. The ends are taken and tied to the tail ends from the previous beams, which should always be left hanging over the back guide roller.

Sizer's Duties.

The weighting strap or band should be put by the sizer or the back sizer on the last two beams of the set. These straps which are placed on the boss of the beam flange are used for the purpose of preventing the back-beams overturning and snarling of the ends when the machine is stopped, or, in other words, to serve the function of a brake.

When the beams have been adjusted and the ends in the new set tied to the tail end of the old one, the pinion on the cone drum shaft is put into gear. The weaver's beam and the friction motion should also be set right. The steam trap leading to the cylinders is then opened. This forces the water out which has been condensed in the pipes, to the cylinders. The taps leading to the boil pipes are afterwards opened. If these taps were opened before the tap leading to the cylinders, the water would be driven into the sow-box. This would cause the size to be diluted, and if the tape frame were situated a long distance from the boiler, there might be sufficient condensed water in the pipes to make an appreciable difference in the strength of the size. After the size has been boiled, the squeezing or finishing roller should be put down, and then the tape frame should be run a short distance on the slow motion in order to allow the sheet of yarn to get straight.

How to Obtain a Greater Sizing Surface.

When too many ends are employed and greater drying surface is required, the yarn is made almost to surround the large and small cylinders by means of extra rollers.

Thirteen or fourteen yards of warp are always drying, although the moisture has been expelled from the yarn by bringing the damp sheet into the closed possible contact with the heated metal surface—first one side of the sheet on one cylinder, then the reverse side with the smaller cylinder.

The twist is now in a very hot state, about 190° Fah. Temporary stoppages would result in even high temperatures in contact with yarn, which undoubtedly reduces the strength and elasticity of yarn.

A couple of fans are used for cooling purposes on its passage into the head-stock; then it goes round the other rollers to the beam. Three to four yards of warp yarn are passed unsized between the copper and the squeezing rollers on account of the knots. The squeezing and the immersion rollers are then put in position. But 14 to 16 yards of yarn are wasted before a proper start is made.

The split rods are pulled out of their brackets and laid on the sides of the machine. The wraith is turned over on account of the knots. When ends have thus been got all straight through the machine, they are then equally distributed over the wraith or comb and the machine is started to work. The method of distributing the ends in the comb is arrived at thus :—

Number of ends in a set $=2500$
Dents to the inch (comb) $= 5$
Size of beam $=50$
Ends per dent $= 50 \times 5 = 250$ dents.
$2500 \div 250 = 10$ ends per dent.

Lease Bands and How to Insert Them.

Lease bands which consists of several ends of warp yarn and are a few inches longer than the width between the back-beam flanges have to be inserted at the creel between the sheet of yarn at each point, where the sheet from one beam effects a junction with the sheet from another at the commencement of a set, and also at frequent intervals during its running, that is, after doffing of each beam.

The Falling Rollers.

The falling rollers that rest on the sheet of yarn between two guides are either brass or tin roller, and their centres revolve in brackets fixed on the sow-box sides. The whole arrangement is placed between the back-beams and the immersion roller. Each end of the falling roller works in a perpendicular bracket having long slot in it. The falling roller by descending in the slot takes up any slackness of the yarn caused by the back-beams running irregularly when the machine itself is stopped.

Sow-Box.

The ends then in one sheet enter into the sow-box from the creel, which is usually made of solid teak wood of a rectangular shape. It is divided vertically into two compartments of different sizes, and such partition is known as mid-feather. These communicate with each other at the bottom thus— ■
■

The method of feeding and construction is adopted so that the incoming size will not pass directly to the sizing rollers and to the yarn, by cooking the size in the smaller compartment to enable the fresh supply to mix equally with the rest so that the size actually applied to the yarn is kept in a uniform condition.

The sow-box is $3\frac{1}{2}$ feet wide, 6 feet long and 13 inches deep. The sides are of cast iron. The bottom, front and back are of teak wood 2″ thick. It is furnished with guide rollers usually of brass, and the larger compartment (nearer to the creel) of the sow-box contains copper immersion roller, which lowers or raises the warp in the size by turning a handle by means of a rack and pinion. It is frequently necessary to change the position of this immersion roller, since the size is not always of the same depth in the sow-box, and yet the size should continually cover the same amount of surface of the immersion roller, at least while sizing the same set of beams, in order to insure the yarn being uniformly sized.

The Immersion Roller.

The lower, but not too low, the immersion roller is placed, the longer the yarn remains in the size, and consequently the greater amount it absorbs. In the case of pure sizing, the roller must be placed lower, but, not so low as to form half biers owing to the size being much thinner and less Sticky than that used in medium or heavy sizing. If any place is left uncoated, soft places will be the result. In the case of medium or heavy sizing, the size must be kept at a sufficiently high level in the sow-box, covering the copper roller entirely, as the point at which the size is actually applied to the yarn is where the copper and the squeezing roller meet.

The plunging of yarn into the hot size by means of the immersion roller does assist impregnation by the preliminary wetting out of the yarn in its passage through the size. It is actually at the nip or point, where the squeezing roller rests on the copper roller, that the yarn is finally impregnated with the required amount of size

and at the same time the surplus size removed. The diameter of the roller varies, a diameter of $4\frac{1}{2}''$ inches is very common. The immersion roller should be so adjusted as to give a level sheet free from half beers.

The Squeezing Roller.

The size roller has an external diameter of $9\frac{1}{4}$ inches and a shell either brass or copper up to half an inch thick. There is also a heavy iron squeezing roller.

The copper roller is the most important roller about the sizing frame and no machine can turn out satisfactory work with an imperfect one. The sizing roller should be set perfectly level in the box and its surface kept quite smooth and free from dents, scratches or uneven places, as upon its good even condition depends the uniform application of size to the yarn. The sizer must be very careful, whilst cutting a lapper from it, not to injure it by the point of the blade of the knife making deep scratches on it, which has a tendency to nip the yarn as it passes over them. The size or copper roller is positively driven by means of bevel gears situated on the side of the slasher, while the squeezing roller is driven by frictional contact with the lower or the copper roller on which it rests. A squeezing roller is usually 6 or 7 ins. in diameter, generally made of cast iron with a hollow shell. A strong wrought iron or steel shaft passes through the entire length of the copper roller, and projects at each end to form gudgeons. These are mounted in bearings formed in the sides of the size box and furnished with packed or stuffed glands to present the leakage of size, and make the opening as much as possible size-tight. The roller shaft is formed with a forged collar near one end, against which there abuts one of the rollers end blocks, whilst a nut on the opposite end of the shaft is screwed up sufficiently to effect a secure binding of the roller tube and shaft. These revolve together and are driven positively through the medium of a bevel wheel, fixed on one end of the roller shaft geared with a similar wheel on the long side-shaft of the sizing machines, which drives the draw or drag roller at the front of the machine. As the squeezing roller is carried in vertical slots, this can be raised if necessary and placed on stands, thus bringing it out of contact with the size roller. A squeezing roller is usually 6 or 7 ins. in diameter, generally made of cast iron with a hollow shell. The weight depends on the width of the machine, general range of ends in the warp, size per cent required, but it may be 360 lbs. for medium sizing, 300 lbs. for light sizing and 400 to 500 lbs. for heavy sizing—60 to 100 lbs. per foot of body.

If the squeezing roller is too light in weight, an excessive amount of water will pass along with the yarn, thus imposing extra work on the drying cylinders, and causing the latter to 'clog' at the expense of the sized yarn not having the desired 'feel'. On the other hand, if the squeezing roller is too heavy, there is the danger of excessive squeezing and flattening of the yarn. The ends travel under the immersion roller, thus being soaked under the surface of the boiling size, thence between the copper and iron squeezing roller, which is covered with cloth and flannel, and these two rollers grip the sheet of yarn sufficiently to pull it from the section beams and through the size box.

The squeezing roller being made of cast iron, it is necessary to be covered to minimise corrosion. In covering such a roller the body should be first thoroughly cleaned, and if necessary skimmed up smooth. The roller should be given two white-lead paints or anti-corrosive paints and then covered with three or four layers of strong calico fent. In placing the cloth on the roller, care should be taken to have the laps fall on the outside, so that they will not be roughed up. Another coat of paint now may be applied on top of the calico and allowed to dry up. After the paint has dried up, two or three pieces of flannel (plain or twill weave), cotton warp and woollen weft, weighing about $9\frac{1}{2}$ ozs. per square yard—each $2\frac{1}{2}$ yards—are wound on top of the calico cloth. In case the size is a little heavier than required, and to avoid adding water to the size in the sow-box, a piece of $2\frac{1}{2}$ yards of calico cloth wrapped up on top of the flannel will answer the purpose of reducing the weight. It also helps to remove the superfluous leaves from the yarn and thus help in cleaning the yarn. The cloth if used for the purpose of cleaning or removing the broken leaves from the yarn should be renewed every hour, otherwise, instead of cleaning it, will impart the collected leaves in patches.

The writer has successfully used hessian cloth in place of the flannel from 40% size and upward.

Bear in mind that on the firm and even surface of the squeezing roller depends to a great extent the quality of the sizing. The flannel cloth should be removed off the roller every night and soaked in water. The water is squeezed out of it the next morning and used again.

The use of new flannel and softer and elastic surface is necessary when more percentage is required.

Stripping of the Iron Roller.

The iron squeezing roller should imperatively be stripped twice a year in the least. This will minimise the tendency of the iron rust which forms on it. Whilst lowering the finishing or squeezing roller on to the copper roller care must be taken, as the shaft in the latter can be easily strained, if it is dropped abruptly. The size roller and squeezing roller should be washed with cold water every night after the day's work or for the interval time, or in case of accident, etc. A water pipe placed on the top of the sow boxes along the frames with a rubber pipe attached to it for each individual machine facilitates the washing of the rollers whenever an occasion arises in place of a degging can, and thus reducing the size too much in consistency may be minimised. It is always wise, for the sake of maintaining uniform weight, that two or three buckets of size be removed from the sow-box and fresh size added after restarting, either first thing in the morning or after the interval hour.

Copper Boiling Pipes.

The sow-box is supplied with copper boiling pipes extending along the bottom of the box from side to side from which steam is injected into it. The boiling pipes are connected to a branch pipe from the main steam pipe which is connected to the boiler. They are constructed from straight copper pipes coupled together in a parallelogram form, with an inside diameter of $\frac{3}{4}$ of an inch. The holes in these pipes are perforated in two rows in each pipe, They are drilled alternately thus∴∴about 5 inches apart, starting, say, $2\frac{1}{2}$ inches inside from the sides of the box. The size of the holes should be 1/16 of an inch. The holes should be placed in a direction parallel to the bottom of the box. that is, slightly below the pipe centre, so that the steam will emerge in a slightly downward direction, and thus assist in preventing settling of size on the bottom of the box.

There is also one independent straight pipe in the mid-feather to boil the size properly and this always be in the fittest state for application to the yarn. The pipes should be placed such that they will receive steam from both the ends. There should be a separate cock valve $\frac{3}{4}$ of an inch fitted to the pipes that are in the mid-feather and the sow-box to provide a ready means of regulating steam by the sizer to his requirements. It is very important to carefully regulate the amount of steam admitted to heat the size.

It is perhaps better to have two sow boxes heated by means of indirect steam with four squeezing rollers for better penetration

and percentage control. It is important that boiling temperature of 212° Fah. or as near to it as possible, is maintained in the sow box to facilitate maximum penetration. The level of size in the sow box should be maintained at a constant height. In light size, a float valve does it satisfactorily; in heavy size the back sizer has to lower the immersion roller as the size is being consumed by the yarn before taking a fresh supply. With the usual sow boxes and direct steam arrangement a variation of 8 to 10 per cent is considered normal.

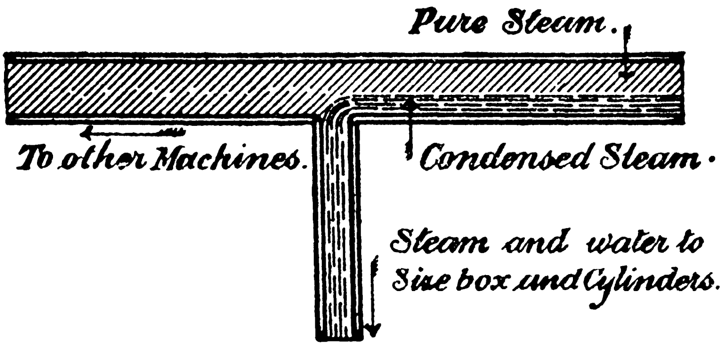
Pipes and Pumps.

The pipes leading from the becks to the pump ought to be from 2 to 2½ inches in diameter in order to avoid trouble when pumping the size. The pump should not be less than 3-inches in diameter. There should be a return valve to each beck so that the size can be pumped from any one beck to any other. All changes of direction in the piping should be made with bends of a long sweep in order to avoid placing unnecessary work on the pump, which is the case when short elbows and sharp bends are employed. Where the size has to be pumped long distances, it is advisable to have the pump driven by a separate strap instead of by the one which drives the mixing becks.

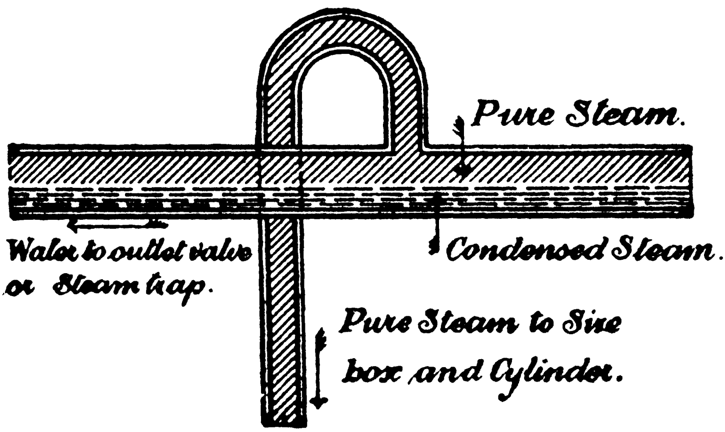
The part of sow-box farther from the creel or nearer to the cylinders receives the mixture directly from the mixing vat by means of a copper pipe which is known as feed pipe through which it is pumped or fed by. The feed pipe travels over the sow-box and then branched off for each sizing machine. The feed end is connected to the sow-box by one of the sides of it.

The admission of size to the sow-box which is regulated by a valve requires keen watching so as to keep about the same quantity in the box at all times and to frequently admit a new supply in small quantities. There should be an easy flow of size from mid-feather box to the sow-box; to maintain the homogenous character of the size it should be kept at a constant level, density and temperature in the size box. In fact the size should be applied to the yarn a little in boiling state, if the size is cooked, and, if not cooked, or half cooked, a greater amount of steam will be required, and there is always a danger of ununiformity of size being applied to the yarn, and hence uneven feel in the cloth will follow.

Method of Fixing over-Head Pipes.



This illustrates the ordinary method of fixing over-head pipes. The junction is made at the under side of the pipe, and naturally, the water being heavier than the steam—it lies at the bottom, and at the first outlet drops into the size box, or cylinders.



By this arrangement perfectly pure steam is conveyed through the upper pipe, which after rising six or nine inches is then turned and continued down to the size box and cylinder a regular and even supply of steam is then secured, in cold or hot weather. Of course care must be taken to have a surplus supply in the pipes.

Condensed Steam Tend to Reduce consistency of Size.

The condensation of the steam constantly tends to reduce the consistency of the size, so that if long intervals elapse between admitting fresh size, the mixture is apt to become too thin, and later when new size is admitted it becomes too thick, causing a variation

in the percentage placed on the yarn; hence there will also be difference in the feel of the cloth. To prevent this the steam employed for boiling the size should be passed first through a steam trap.

Float Roller.

Some of the sizing machines have a float roller in the cavity and it is made of copper. It is used to control the amount of size in the sow-box. The float roller is pivoted at one end in a bracket fixed to the inside of the box, the other end being free to move in a vertical slide, and also is connected by links to the screwed spindle of the size valve on the supply pipe.

If sufficient care and attention are given to the float roller it will work satisfactorily, as the size level, in the sow-box tends to fall; the float in falling with it will open its valve and allow fresh supply into the sow-box from the supply or size beck. If the level tends to rise then the float in rising closes the valve. In this way a uniform level of size in the box should be maintained.

An extra size box is required to serve for warp of two colours. This is placed above the bottom box and is termed colour sow-box.

Feeding of Size by Gravity or Pump.

The size should be supplied to the sow-box by means of gravity rather than by pump if the size mixing room is situated on a higher level than the sizing department, but if it is not so situated, then a pump with 2½ inch ram in diameter with a stroke of 6 inches and working at 35 strokes per minute. The valve should be of 2 inch suction and 2 inch delivery. This will deliver about 3.5 gallons of size per minute. Such a capacity will sufficiently fill up the sow-box when starting a set in about 10 minutes. If possible a group of three such pumps employed with a connection leading to all the becks will be better still, and thus be able to deliver 10 gallons of size per minute, and be able to fill up the size box in about 5 minutes.

The size is withdrawn from the vat on the upward strokes and forced through the size piping on each downward stroke of the ram, suitable loose valves or clacks opening and closing the inlet and outlet sides according as the pressure alternates with the rise and fall of the ram. These clacks fit into removable seats and the working faces should be ground smooth and fit accurately in order to give a good joint when closed. It is possible to make slight adjustments to the amount of lift of clack by screwing down the cap or cover which fits into the pump body above the valves.

The overflow valve is provided with a lever and a balance weighe which normally tend to lift the valve against its seat and keep it closed. The weight should be accurately adjusted upon the lever

so that as the float va ve or the ordinary valve closes, the increasing pressure of pumped size will open the overflow valve and allow the excess to flow back through the branch pipe.

The Cylinders.

Adverting to the process of sizing the warp, we come now to the drying. This is done by means of two copper cylinders, the larger one being nearer the front of the frame or the head stock. The cylinders are made of rolled copper, except the heads which are of steel plate. Copper is better than iron or steel as a conductor and retainer of heat. Internally they are strongly stayed by numerous wrought iron rods by which the danger of an explosion or collapse is reduced to a minimum. Each cylinder is provided with a cast iron shaft extending through the centre, which constitutes a strong stay to the cylinder ends, and also forms the inlet for the admission of steam, and the outlet for the condensed water. On both sides of the cylinders perfectly air-tight connection must be so made that steam can be admitted on one side and condensation water flows out on the other side. Asbestos packing is introduced to make the connections perfectly tight. Copper buckets are fitted in each cylinder to conduct the condensed water away. The cylinders are mounted on brackets fitted with anti-friction bowls, on which the ends of the shaft rest; thus the cylinders are easily pulled round by the pull of the yarn, that is, the cylinders are not driven positively, but they may be made to drive positively if required in case of fine yarn, or when very small number of ends are used. This arrangement reduces the power required to turn them to a minimum. Frictional resistence between the cylinder journals and bearings is greater with ordinary cup bearings than with roller bearings and is least with ball bearings.

The sizer should carefully see that the friction bowl upon which the cylinder trunnions rest are kept in efficient working order. If yarn and dirt be allowed to get entangled with them, and if oiling and cleaning be neglected, they will either revolve irregularly or cease to revolve at all. The consequence would be that a large amount of the natural elasticity of the yarn would be taken out at this point instead of being retained for the process of weaving. If the glands of the stuffing boxes are screwed too tightly then unnecessary tension would be created.

They are also provided with (1) manholes, through which access to the interior can be obtained by removing the cover; (2) air valve

by which a collapse of the cylinder is prevented when the steam condenses and a partial vacuum is produced, as is the case whenever the steam is shut off; (3) steam gauges from which the pressure of the steam in the cylinders can be read; (4) brass bottle safety valve which is usually of the dead weight (Cowburns) or spring type and opens to blow off when the pressure of the steam exceeds a little over 10 pounds or at any desired pressure; (5) two steam traps; (6) reducing valves; (7) glands, and (8) junction pipes.

Pressure of steam

Steam must be brought into the room at a high pressure, that is, whatever may be the boiler pressure, say, 150 lbs. per square inch, then reduced to 30 lbs. per sq. inch; but to get uniform steam the best plan is to insert a steam trap at the bottom side of the pipe before the first outlet, and wherever it is necessary, if the steam has to travel a long distance from the boiler before it reaches the sizing machine, in order to prevent too much water entering the sow-box, which will naturally help to dilute the size, and thus give unsatisfactory results, such as variation in weight, feel, etc. Too much water must also be prevented from entering the cylinders.

Efficiency of drying

The efficiency of drying will depend on steam temperature and pressure, the conductivity of heat by cylinders, and the humidity of the sizing room. The sizing room must be properly ventilated to expel the humid air.

The joints of all steam pipes and also the glands of stuffing boxes of the cylinder journals, where these are connected to the steam pipes, should be well packed and made perfectly steam-tight, and all leakages of steam, however small, should be stopped immediately on discovery. All branch pipes leading to the drying cylinders, size boxes, and size boiling becks should pass from the upper side of the main service pipe with a syphon bend, thus ∩, to prevent the evil known as 'pruning' or the passing of water either that escapes from the steam boilers, or else that of condensation, together with steam, down the branch pipes and into the cylinders.

Also all steam pipes that run horizontally should be set with a slight indication in such a direction as will assist the water condensation to gravitate towards the steam traps, and thereby reduce the risk of the water lodging in the pipes, especially after the steam is shut off for a prolonged period.

Width of Cylinders as specified below.

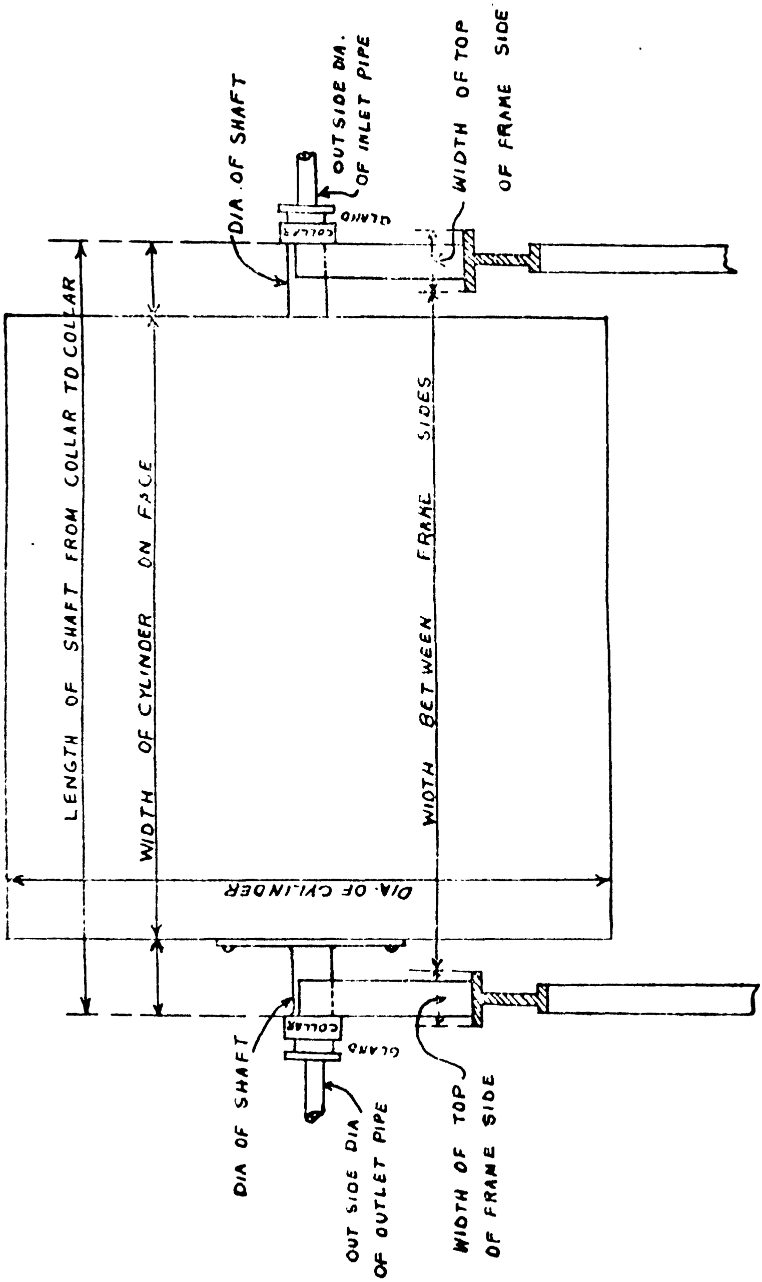
Width of Machine.	Width on face of Tin Cylinder.	Width on Drying Surface of Copper Cylinder.	Extreme Distance between Flanges of Weavers Beams.
9/8's	60 inches.	$56\frac{1}{2}$ inches	52 in.
6/4's	66 ,,	$62\frac{1}{2}$,,	58 ,,
7/4's	72 ,,	$68\frac{1}{2}$,,	64 ,,
8/4's	78 ,,	$74\frac{1}{2}$,,	70 ,,
9/4's	84 ,,	$80\frac{1}{2}$,,	76 ,,
10/4's	90 ,,	$86\frac{1}{2}$,,	82 ,,

Machines of greater width can be supplied, advancing by 6 in. at a time up to 16/4s wide. When broad warps are occasionally required, the creel part, size box and cylinders may be arranged to suit the lesser width of warper's beam and the front or head-stock part of machine made one, two, three, or even four sizes wider than the back part of machine; the difference should not, however, exceed 4 sizes (2 ft.), for example the proportion of a 6/4s machine with a 10/4s head stock should not be exceeded.

Various sizes of cylinders

Large	Small.
6′	4′
7′	4′
7′	5′

In comparatively recent times, machines have been built in which the drying cylinders are replaced by a hot-air Chamber. Perhaps a combination of a cylinder and hot air is better than entire hot air or cylinder drying. This will combine the efficiency of the cylinder without the risk of baking.



Plan showing Details for ordering out a Copper cylinder for sizing machine.

Notes for cylinder users

Avoid wet steam

Water in cylinders destroys red lead joints round studs and stay bolts on end plates, also between end plates and body. Shown by leakages round washers and steam blowing across face of cylinders

Wet steam may be expected

When boiler pressure is low. When boiler is a long way from the cylinders and the pipes are not covered or lagged. Separators on pipe line or drains help to get rid of water before it reaches the cylinders, as does superheating the steam. Steam temperature must not exceed 300°F. when turned iron cylinders are used.

Make sure your cylinders are well drained

Outlet from steam trap should be large and free, traps should be of ample size as should all water piping.

Valves

Both reducing and safety valves should be periodically examined by some competent person. None other should tamper with them. The pressure on the high pressure side of the ordinary piston type of reducing valve should not exceed 40—lbs. per sq.-in.

"Safety valves must never have extra weights added. They should have an outlet area at least 1¼ times the area of steam feed pipe and should be of the padlocked cover type."
Raised seams are indisputable evidence of over pressure.

"Warm Cylinders up Gradually when Starting."

By admitting steam too rapidly, air in the cylinders is expelled. The inrushing steam condenses, a vacuum is formed, and the cylinder collapses. Between this extreme and careful warming up, come the cases where the cylinder resists the collapse, but gets rapidly worn out in combatting the strains set up.

Seams cracking is generally the outward sign. About 20 minutes should be spent in warming up a 7′-0″ cylinder, revolving same to clear of water, other sizes in proportion.

Periodical Inspection By An Expert is Essential. A pressure gauge must be fitted to each machine. It will be misleading and dangerous unless inspected and kept in perfect order.

Pressure of gauge

The working pressure of usual gauge copper cylinders should not exceed 12 pounds per square inch owing to their immense surface and light construction, and also on account of the fact that a high pressure of steam means a high temperature, which would tend to burn the yarn on the surface of the cyliuders or make it brittle.

Each cylinder should have an independent for the inlet of the steam so that the steam will be controlled as required to meet the condition of the yarn.

The pressure depends upon the number of ends being slashed, that is, it varies from 4 to 12 pounds. A high pressure of steam is used when coarse yarn is being sized and when a large percentage of size is applied, also when there are a large number of ends being slashed. Dry steam at 12 lbs. pressure shows 242° Fah. Ten pounds on the gauge represents 24.7 pounds pressure or 10 pounds above atmospheric pressure (that is 14.7 lbs.) Better work can be done with a machine running slowly and the cylinders at a moderate temperature than running the yarn through very quickly. If the yarn is damp it will mildew and rot, also form balls or beads of cotton on the yarn on the loom, and hence making bad weaving and sometimes even making it impossible to weave the beam out. Therefore the beam is cut out and put on one side or wasted. But in the case of forming beads on the yarn in the loom the weaver should attempt to weave the beam by dusting some french chalk on the yarn which helps the yarn to weave better.

This can be repeated as often as required with little perseverance. In such cases it will also help if the picks are reduced a little.

Automatic steam cut off

It is applied to some of the machine which cuts off steam the moment the machine is stopped. No sizing machine should be without one, and it is the duty of the sizer and the overseer to see that this is kept in proper working order.

The steam pipe, in addition to the branch pipe for the size-box, and another branch pipe that conveys the steam to the two cylinders by means of a cock valve or wheel valve have also connection to it. The steam may be shut off from the cylinders independently of the size-box.

The steam that rises from boiling size in the sow-box and also the moist air produced by the drying of the yarn on the cylinders is quite appreciable in quantity, and if some arrangement were not provided to carry this from the slasher room, the atmosphere would become detrimental to satisfactory work. To provide for this, a wooden trunk for covering sizing machine cylinders and size-box is used to conduct waste steam away. If the cylinders are allowed to cool down the steam that has been present (previously introduced) will condense forming water which is detrimental to the good work of the cylinders.

There are two or three water buckets or ladels placed at regular intervals inside the cylinders. From each of these water buckets a pipe leads into the inner end of the cylinder journal to the outer end of which there is attached, by means of a packed gland coupling, to prevent the escape of steam, an external pipe leading into a steam trap. As the cylinder revolves, the water buckets arrive successively at their lowest position, and scoop or ladle the waste water of condensation, which, as the buckets ascend, flows down the outlet pipes, and is thereby discharged into the cylinder journal whence it flows along the external pipe to the steam trap, which intercepts and prevents the escape of steam, although it allows the water to pass away freely into a res rvoir.

Steam Trap

A steam trap is a box containing a float, which is regulated so that at no time can the valve be open when the surface of water is below the opening of the pipe. The water is drained off by the pipe to some suitable place. An atmospheric valve is also provided on the trap in order to reduce the difference in pressure between the air pressure on the outside and the vacuum that is formed when the steam in the trap condenses. There is also a blow-off cock that may be opened when the steam is first admitted to the cylinder, thus allowing the air in the chamber to escape as the steam enters. When repairing broken ends or whilst doffing a beam, etc., it is very essential that the steam from the cylinders should be shut off, otherwise the warp ends on the cylinders will get burnt.

Spring Bearing for guide Rollers

In many cases one of the guide rollers is fitted in a spring-cushioned bearing which allows the roller to give a little when restarting the machine, thus minimising the possibility of injury to the yarn by a sudden pull.

Head stock

The head stock of the slashing machine consists of frame work holding polished rods that are inserted in place of lease bands for the purpose of separating the whole sheet of yarn into as many sheets as there are back beams. But the number of rods employed is always one less than the number of back beams. The lease rods are hollow iron rods pointed at each end. They are placed across the width of the machine parallel with each other at regular intervals of 12 to 18 inches apart at slightly different elevation to avoid unnecessary chafing of the yarn, into brackets on each side of the head stock.

As the lease rods have to undergo a constant friction of the yarn they wear fine grooves in them. These grooves should always be removed from them by means of emery paper or emery wheel or turned up on the lathe according to the nature of the grooves, otherwise if these grooves are too deep, they will damage the yarn during the insertion of the rod and during the passage of the yarn.

The head stock also holds in front of and parallel with the weaver's beam, the wraith or the expansion comb through which the ends from the split rods pass in group, and thus the sized ends are separated, wraiths are made capable of easy expansion and contraction, so that the width of sheet may be adjusted to suit any possible variation in widths of weaver's beam.

In order to assist the taper in laying in at the beginning of the set, a striking comb with a number of teeth evenly set is inserted into the sheet of yarn, just prior to it entering the sow box, and held there until several yards have been run through the size.

This will facilitate the laying out at the wraith as the striking comb has the effect of separating the sheet into a large number of small tapes. The expansion comb also guides the yarn on to the loom beam in such a manner that the outside ends will just be within the beam heads.

The wraith is fitted with iron slightly inclined or straight teeth or dents, each of which is inserted between the coils of a series of spiral springs. The ends of the springs are fastened to a bracket which also acts as nut, one of which has a right and the other a left hand thread, and are screwed on a rod. By turning the handle at the front of the machine, the sizer can impart a rotary motion to this rod. If the handle be turned in one direction the spiral springs are stretched, and all the teeth or dents of the wraith expand equally.

If the handle be turned in the other direction they contract. The sheet of yarn laid in between the teeth can thus be made wider or narrower as required. The teeth of the wraith should be examined periodically in order to ascertain whether the grooves are being worn in them. This condition should be avoided as the threads tend to run in the grooves. The consequence is that if there is any unevenness in the thread, or if there is a knot or lumpy place, the yarn generally breaks, producing crooked ends and causing extra work and annoyance for the weaver. The renewal of dents specially at the side of the wraith will stop this trouble.

Dents to the Inch

There are 6 or 7 dents to the inch, or as the case may be. The number of dents to the inch of the wraith should always be borne in mind, as this is required for working out the number of ends of a new set to be dented, each dent according to the pattern required in the cloth. There are also zig-zag wraith for sizing machine in use.

Drag roller

The drag or draw roller is a built up wooden roller having a wrought iron shaft in the centre upon which it revolves. Two heavy iron rollers known as the nip rollers rest on this roller. All the three rollers are used for the purpose of pulling the yarn from the cylinders and delivering it to the weaver's beam. The drag or draw roller derives its motion by means of a spur wheel from the small pinion on the end of the driven cone drum shaft.

It is also geared with the copper roller by means of two pairs of bevel or mitre wheels on the side shaft. The side shaft helps to relieve the tension of the yarn by having it delivered to the cylinders positively and taken from them in the same way.

The circumference of the copper roller is constant, but the draw roller is wrapped with several rounds of fents in order to prevent the yarn being injured by nip rollers revolving on the top of it. As the sizers are in some of the mills on piece work, and in order to get the work done quicker, they put an extra fent on the draw roller, the effect of which is to tighten the yarn round the drying cylinders. This causes the yarn to dry quicker owing to its being brought into close contact with the hot cylinders, thus allowing the frame to be run at an increased speed at the cost of the elasticity of the yarn. It is a direct evidence if the yarn does not sag as it travels between the copper roller and the top of the big cylinder, also it must sag between the first guide roller on the head stock nearest the large

cylinder and the first lease or split rod when a pressure is brought by the hand to bear upon it. The head stock is also furnished with two fans for the purpose of cooling the yarn after being dried by the hot cylinders and before it passes to the weaver's beam. If the yarn were wound whilst in a warm state on the weaver's beam and then allowed to cool naturally, the process of cooling would create moisture in the yarn, thereby condensing to the developments of mildew, and also causing the warp threads to adhere together. The fans are driven from the machine shaft with high velocity to create a strong current of cool air which is fanned on to the yarn.

Marking motion

A drop marking motion is provided to enable the weaver to finish the piece when required length has been woven, that is,at the mark (which is smeared with coloured stains) the weaver has to insert at the required intervals apart in the piece a distinctive mark usually consisting of cross bands or stripes of coloured or other different kinds of weft, to produce what are variously termed 'fancy headings.' 'cross boarders,' or 'cut' marks (that is, where the piece has to be cut).

The cut marking device consists of a striking hammer which is placed above the warp threads with the colour block immediately below them, so that the cut marks will be impressed upon the yarn. The striking hammer is secured to a short stud or shaft which freely enters a sleeve bearing supported by a fixed bracket. The hammer in its normal position is held quite clear by a space of several inches above the warp threads until it is required to strike a cut mark, when it drops down all of a sudden, thereby deflecting those warp threads beneath it to produce a momentary contact with the colour block, and thus stain with a mark about 1¼ inch by 2 inches after which the hammer rebounds instantly to its normal position. The recoil of the hammer is effected by means of heavy counter-weight at the rear end of the hammer to over-balance it.

The colour block is a circular iron disc fixed on one end of a shaft both of which revolve together with a slow velocity. The rim of the colour disc is covered with cloth to produce a soft pad against which the threads are struck by the hammer without the risk of injuring them, and it revolves with its lower portion immersed in a solution of colouring material of any vivid hue, contained in a narrow chamber, which entirely closes the disc, excepting for an opening at the top where the rim is exposed.

For every revolution of the stepped cam the hammer drop down upon the yarn and strikes a cut mark, and the intervals of length between successive cut marks are determined by the velocity with which that cam revolves in relation to the velocity of the measuring roller.

Bearing constantly downward against the surface of the stepped cam is the free end of an ┍—shaped arm L termed the cam lever, extending from the same bearing as that which supports the striking hammer, and which is always held downward by means of a blade spring. A free union or clutch joint between the shanks of the cam lever and striking hammer permits each of these arms oscillating independently and instantly on the step of the cam passing from underneath, and thereby releaseding the cam lever. Whenever this occurs that lever descends with a sudden impulse and thereby projects the striking hammer upon the warp threads to impress a cut mark.

The measuring roller (=14.4 or $\frac{2}{5}$ of a yard in circumference) transmits motion to the stepped cam. There is a pinion driving wheel (measuring roller wheel) fixed on one end of the measuring roller shaft. This wheel through the medium of a simple carrier wheel transmits motion to another wheel (stud wheel) which is mounted on a short stud. The stud wheel is compounded with a single thread worm of large diameter which gears with a worm wheel (bell wheel) fixed on the same shaft (belt shaft) as that on which the stepped cam is also fixed. The bell wheel contains a constant number of teeth—namely 45—and is moved only one tooth during each revolution of a single thread worm and the stud wheel. These will, therefore, require to make 45 revolutions to revolve the belt wheel and stepped cam once to mark successive cut lengths of the warp The belt wheel is so named from the fact that a tongue T projecting from one side of the bell shaft is caused to ring a bell and so warn the attendant of each approaching cut mark, so hat he may keep a record of the number of cut lengths wound on each weaver's beam. The belt shaft also contains a bevel wheel which throarh the medium of a similar bevel wheel (but preferably one tooth lugger) fixed on a short shaft that carries the colour disc, revolves that disc with a very slow velocity to bring up the colouring mat erial. By having a difference of one tooth more or less between the bevel wheels it will prevent the colour hammer from striking in succession on the same part of the rim of the colour disc.

Cut-Measuring motion

There is also a cut-measuring motion to indicate cut-length of warp wound on. It consists of a fixed dial plate on the face of which

there revolves a finger operated by a single thread worm on the bell shaft which transmits motion to a worm wheel fixed at the bottom of the finger stud. The dial plate is usually graduated in both quarters and unit length of cuts to indicate either up to 10 or else 20 cuts for one revolution of the finger according to whether the worm wheel on the finger stud contains 10 or 20 teeth respectively.

Dhoty marker

Before commencing each new weaver's beam the step of the cam is set close up to the cam lever. This is effected by means of a small hand-wheel on the forward end of the bell shaft which is turned until the step of the cam stops against that lever, after which the finger is also re-set to zero on the dial plate. Additional marks have to be made where the heading for each scarf or *Dhoty* or *Saree* has to be put in. Usually this is done by having an additional train of wheels and an extra marker, called a *Dhoty* marker, to strike 3 or 4, etc., times for the cut markers once. The marking motion can be made to act at any required length from a few inches to almost any number of yards. The usual range of wheels used for both stud wheel and tin roller wheel is from 15 to 120 teeth, by means of which it is possible to get cut lengths of sufficient accuracy from 1 yard to 144 yards. In order to get lengths other than are possible with the above range of wheels, it may be necessary to use fresh bell wheels, say, of 25 or 50 teeth.

Hitchon's marking and measuring motion

Hitchon's marking and measuring motion dispenses with change wheels. It can be set to mark any length in inches upto 200 yards as follows :—

In the beginning, the required length in yards should be converted into inches. Then set the dial plate to zero mark and in gear with the small striking pinion. At the back of the dial plate there are spur wheels and one of which is an adjustable wheel and which has a pin that can be made loose by a box spanner. This wheel gears with another wheel and both of them have one projecting tooth. At the same time keep the projecting teeth of the other pair of spur wheels in touch with each other. Now take the small-pinion out of gear from the Diel-plate wheel and turn the Dial up-to the total number of inches. Put the small pinion in gear with the Dial-plate-wheel, and bring the projecting tooth of the adjustable Spur-wheel with the tooth of the opposite spur wheel and tighten the pin. Thus according to the required mark in inches the Dial plate will turn in both the directions.

By this means the continuous automatic reversing motion is kept up, turning and reversing the Dial–wheel and its pointer from zero to any position and from any position to zero, at which it is set.

The belt which drives this motion must be kept in proper tension and its inner surface imperfectly dry condition, so as not to slip at the time of marking and the sensitiveness of its working must be preserved by cleanliness and lubrication. In case the cut mark is found to be measuring longer than it should be then deduct 5 inches from the total inches while setting the gearing wheels.

Speed at which the yarn Travels

The sizing and squeezing rollers in the size-box revolve at a constant speed and consequently pull forwards the same number of yards during each minute. The drag or the flannel covered roller being a little larger in diameter than the squeezing roller is geared to take up just the amount delivered by the size roller, or draw the yarn forward at a constant rate for a given position of the cone drive which is regulated by hand. The cone belt fork is attached to a screw which the tenter or sizer turns from time to time, thus moving the belt to a diameter of the driven cone and a smaller diameter of the driving cone or *vice versa*.

The yarn must be wound on the beam at a constant Speed of about 20 yards per minute and may reach to 30 yards or more per minute, to correspond to the rate at which it is delivered by the drag roller to maintain a constant winding rate of yarn on to the gradually increasing diameter of the loom or weaver's beam. In order to meet these requirements the beam instead of being driven by friction is so arranged that the pull exerted on the yarn by the loom or weaver's beam tends to increase as the beam increases in diameter. The friction drive will yield and allow sufficient stoppage to prevent the loom beam being driven any faster than is necessary to take up the length of yarn delivered by the drag roller.

Tension on yarn in machine

Though there is a slight difference between the diameter of draw roller and the copper sizing roller, the sizes of the intermediate gearing are so arranged as to give theoretically equal surface rates; hence it is necessary to cover the drag roller with sufficient layers, say, 3 to 4 laps of heavy calico cloth or sizing flannel to provide a

satisfactory surface for gripping the yarn, and also to assist in making necessary adjustments to the tension of the yarn between the sizing rollers and the drag roller to keep the yarn taut at the head stock, splitting rods and wraith. But it should be possible to deflect the sheet of yarn easily with the hand and without feeling any undue tension, because over-stretching of the yarn can easily be carried at this point, hence care should be exercised to watch every change of set now and again. The tension to make adjustment if necessary as slipping bevel wheels on the side shaft are a cause of tight and over-stretched yarn, therefore this point should also be watched.

Elongation length

The elongation of yarn length should not exceed $\frac{1}{2}$ to $\frac{3}{4}\%$ and this should be watched by keeping a record of sized length obtained from the unsized length in the set. Too much elongation in the yarn means loss of elasticity which again means loss of production in the process of weaving.

The belt from the driving shaft is passed round one of the three pulleys which are, *viz.*, fast, slow and loose or stop.

Fast Pulley

Keyed on to come shaft and used for driving machine at working speed.

Loose Pulley

Fitted loosely over the boss of the slow motion pulley.

Slow motion pulley

Fits loosely on the cone shaft and is very slightly larger than the fast and loose pulleys, but has an extended boss carrying a small spur wheel, gearing with slow motion drive

Starting machine

The extreme position of the handle either stops or runs the machine at full or normal rate, and in starting the first speed given is from the slow motion, a further pull of the rod in the same direction applying the fast speed. The pulleys rest on a cone shaft in the front part of the machine. Thé cone drums are made in single casting in machine driven through the medium of a pair of cones and a strap for the purpose of varying the speed at which the yarn travels. The driven cone transmits by means of wheels the motion to the beam and also to the draw or drag roller on the head stock of the machine as already described. The slipping of the strap, which frequentls

happens when the slow motion is put on, in the event of a lapper, that is, one or more broken ends or threads running around a back beam, gives rise to inconvenience and bad work from the baking of the yarn. This is because of the well-known fact that a strap running slowly cannot drive a machine with the same certainty as when running fast, and for this reason cone drive in sizing machine with the slow motion sometimes stop altogether, and therefore when started again on the fast motion the strap is strained to an undue extent, and what is more objectionable that it strains the yarn also. The difficulty or drawback is overcome by driving the machine positively by a gearing, the cone strap being then virtually imperative, by shifting the main driving strap from the fast to slow motion pulley. The driving cone is put at liberty, and the driven cone, through the medium of which the machine is actuated, is driven by means of the short side shaft and gearing which reduces the speed to the extent arranged for. There is naturally a point at which the fast speed as it reduces becomes the slow speed proper, and would become slower, but before this can actually occur, the slow motion becomes operative and maintain from fast to slow, although the main strap is on the latter, and the slow motion therefore working, it is not still operative. The driven cone drum shaft is turned from the slow motion by a click and ratchet wheel, which allows the shaft to go faster, but not slower, the click slipping into gear before this point is reached, the cone strap being then moved by the slow revolution of the driven cone, although it does nothing. The cone drive proves advantageous for altering the speed according to the class of work; different speeds are required for light and heavy sizing, the latter, for instance, needing a longer time to dry than the other, running a little slower first thing in the morning when all is cold, sometimes used when the back beams are getting near the termination, so as to avoid jerking and overrunning themselves when the loom beam is nearly full, or during the winding on the final cut, the speed of the machine may be slackened a trifle and accelerated when starting an empty beam the machine may be run quicker than the cylinders are at a good heat for drying the yarn so that the yarn will not be scorched or slowed down when the cylinders are not drying the yarn as quick.

Control of pulley

As sizing machines are rather long frames and it is essential for the sizer to supervise the machine as occasion demands at various points from front to back, it is important that good correctly set strap fork connections should be arranged. There should be at least four places on each side of the machine from which the machine

pulley may be controlled, namely, front machine, near to wraith, sow-box and back beam creel.

Variations of temperature

Sometimes the size varies in density, and the amount of drying becomes either insufficient or excessive therefore the weights of warps will vary considerably. It is usual that one machine or rather the same machine turning out sorts which give a sizing rate ranging from 15 to 60 yards per minute. Not only will the rate of sizing be influenced by the weight of yarn and class of size between one set and another, but during the running of a single set it will be necessary to adjust the speed to counteract variations in the temperature of drying cylinders and the condition of the sizing room, when restarting each morning or afternoon or after gaiting a fresh set of beams, the speed has to be reduced below the maximum to allow the drying cylinders to be fully heated; when a set is being gaited up or a weaver's beam is being changed, it is necessary to run the yarn through the machine at a very slow speed, except when it is required to bring to a dead stop for a moment.

If the yarn is stopped completely for a length of time during the machine in working order, a size crusted place will occur where the yarn is left on the sizing rollers, more so if the squeezing roller is not lifted up. The sizer generally removes the crusted size from the yarn when the yarn is between the drag roller and the beam by means of a long brush with hard bristles. This operation of bru sh-ing the crust of size at the starting of the beam every morning and afternoon is necessary.

The following adustments are required on a sizing machine:—

(1) Owing to drying capacity varying whilst running a set, the speed of the machine should be altered by the use of a pair of cone drums which are operated by changing the position of the belts, and the machine can be started with less risk of jerk.

(2) To allow lappers and other adjustments to be made good, the speed is required to be reduced almost to creeping speed, which is actuated by the use of a slow motion drive.

(3) Besides the cone drum, the speed can be altered by the use of a speed wheel before starting a set. This change is generally required in case of heavy sizing.

The cylinders may also vary in their surface heat, so that it prevents these variations burning the yarn or drying it sufficiently. The sizer can regulate its speed through the machine by altering the position of the cone belt.

Endless Belt

Chain belt or endless belt is best used for cone drums as it avoids slippage and lasts very long. The belt which tapers in thickness across the width of the belt is placed in position on the cone drums by giving it a half twist in such a manner as to cause the thicker edge of the belt always run on the smaller diameter of both and *vice versa.*

Friction and pressing motion

The next point requiring consideration is the method adopted for maintaining any required tension upon the yarn as it is wound upon the beam. The beam is mounted upon a shaft, and one end of the latter fits into a cap which is fastened to a plate by means of bolts in the adjustable shaft and the other of the beam is fixed into a cap in another adjustable shaft. A small belt bracket is much safer than rope, one end of which carries a pin that fits into a hole which is made at one end of the barrel. This barrel comes in contact with a stud carried by a plate which is fastened to the shaft. Thus if the shaft revolve it will act through the plate, stud bracket, and turn the beam. The only connection between the cog wheel and the shaft on which it rides loose, is by means of the friction plates. Unless the two outer flanges are forced up to clip the flannel no motion should be conveyed to the beam. The motion of cog wheel is transmitted through its flanges to the flannel-faced disc, then to the flanges and beam shaft. The greater the pressure used, the greater will be the speed of the beam, until it becomes sufficient to prevent slip between the frictional surfaces, when the speed of both the wheel and the beam shaft will be the same.

Tension on yarn

The anti-friction bowls carried by the lever press upon the friction plates. The lever is fulcrummed upon the swivel, so as to allow the bowls to follow any variation in the plane of rotation of the friction discs. The upper end of lever is connected by the link to the bell crank lever, the larger arm of which carries one or more weights. These weights are secured by thumb screws so that they can easily be moved. By this arrangement it is an easy matter for the sizer to regulate the tension upon the yarn. If he wants more then he increases the pressure between the discs, and if he wants less then he reduces it, thus increasing or reducing the speed of the beam. The friction motion should be adjusted in the course of winding the yarn on the beam, without setting up any unnecessary tension on the yarn between the point where it is delivered from the draw roller to the point, where it begins to wind on the weaver's beam. The tension on the yarn should always be reduced to the lowest workable

amount when winding it on the weaver's beam, thus retaining as much of its elasticity as possible for the process of weaving. The friction between the discs is sometimes very great, and the parts not only get heated, but the flannel washers rapidly wear out and require replacing.

Some attendants keep the flannel washers thoroughly lubricated with the object of both increasing their efficiency and of prolonging their usefulness; whilst other prefer to keep these washers quite dry without employing lubricant whatever, and with equally effective results in each case.

Though it is advisable that the friction motion should be pulled to pieces periodically, the flannel and the discs should then be examined, and any substances, such as rust, dried oil or dirt should be carefully removed. This will then avoid irregular working.

The tension is regulated by means of levers and weights or by means of a Rigby's automatic patent friction and pressure motion. By means of this combined automatic friction and pressing motion, the adjustment necessary to ensure both a constant tension and an increasing pressure upon the yarn are continuous and of an uniformly increasing value from the commencement, to the completion of a weaver's beam, and not of an intermittent and variable character, as when the adjustment is effected indiscriminately at the discretion of the attendant, thereby ensuring more fairly wound and compact weaver's beams containing a relatively greater length of yarn.

The lever carrying the weights is turned up, when the sizer is changing the weaver's beam.

Thus the friction from the discs is removed and this enables the sizer to move the mandril shaft very easily. At the commencement of a beam, the weights on the lever should be minimised to retain the elasticity of the yarn. It should be increased gradually as the beam gets larger. Although the friction arrangement for driving the loom tends to lay the yarn on the beam in a compact form, yet in order to further insure a firm, hard beam being made, it is the custom to apply to slashers an arrangement known as a beam pressure, which serves to press each layer close to the preecdig one. A good pressing motion may admit of 25% more yarn being wound upon the same diameter of beam than a bad one, and this gain also means that four beams will do for five, in doffing, in drawing in, and in gaiting up at the loom, which also makes a saving in the waste from the first pieces and last cuts. It is also customary though not advisable to run the yarn on the weaver's beam, not only until

it is filled up level with the top of the flange but also almost an inch outside the top that is necking the yarn by coining the ends gradually by contracting the expansion wraith, so that the yarn will not fall over the beam flanges and become entangled or slack. The coning of yarn on a weaver's beam which contracts the wraith is operated by as mall ratchet wheel, that is, fixed to one end of the screwed rod which is a part of the wraith. Intermittent motion can be imparted to this wheel by means of a drivîng pawl having a reciprocating motion derived from a cam on the driven cone drum shaft. When the yarn on the weaver's beam is within a short distance of the top of the flange the pawl is put in gear with the ratchet wheel. This causes the wraith to contract, and the sheet of yarn gradually decreases in width as each successive layer is wound on the beam. The sides of the sheet of yarn are thus made to slope inwards, hence a greater length can be put on a beam without much risk of the sides being damaged.

The pressers, in conjunction with the manipulation of the friction, are of most important consideration in determining the perfectness. A good beam ought to be hardly and uniformly pressed throughout its whole length, otherwise the yarn will not easily or uniformly unwind when placed in the loom.

Single and double pressing motion and their actions

There are two kinds of pressers in use, *viz.*, single and double, the former pressing the yarn on the beam with one roller and the latter with two. The single presser has a fewer parts, and is simple in construction. The roller receives a traversing motion between the flanges of the beam, thus keeping the pressure uniformly distributed from flange to flange. The roller, it will be observed, is a tubular one, and in one piece, the total length being somewhat shorter than the width between the flanges. There are some machines which have a tubular roller mounted on a solid interval axle, so as to be capable of expanding, thereby preventing the risk of selvedge warp ends building up too quickly against the flanges. The traversing motion of the presser is continuous and it is mounted on anti-friction bowls carried in a suitable framing called tilting anti-friction bowls. On the axis of this is a worm gearing with a worm wheel, in the boss of which is a pin, which being eccentric to the boss acts as a crank, and by working in the slot, which is in a fixed bracket, the arm carrying the wheel is controlled and operated upon.

In the case of double rollers instead of the bowls having their axis parallel to that of the roller is placed obliquely in swivel brackets, whose positions are changed automatically, thereby causing the tubular rollers to traverse towards or from the beam flanges. The whole arrangement is in connection with, the square cross shaft. This shaft, being movable in its bearings so as to allow the counterpoise adjustable weight to keep the pressing roller is always up in contact with the yarn. By moving this weight out or on the lever any desired pressure of the roll may be brought to bear on the yarn, as it is wound on the loom beam. As the diameter of the loom beam is constantly increasing due to the yarn being wound on it, the beam presses down the roll and at the same time turns the shaft and raises the weight.

During the action the pawl slides over the back of the teeth of the ratchet gear, but does not prevent in any way the action of the roll on the yarn. The object of this pawl and ratchet is simply to hold the weight in position when doffing the loom beam, or in the case it is necessary for any reason to lift the weight and bring the roll out of contact with the yarn. The weight lever cannot descend until it is returned by the sizer to its initial starting position at the commencement of a new weaver's beam.

A loomers' comb

A loomer's comb if struck through the completed warp will keep the ends straight. But the cap of the comb should be tied securely.

Doffing of a beam

In doffing the weaver's beam the yarn should be cut 12 inches from the last mark. This is to allow for gaiting up of the beam. If even a few inches beyond this is allowed, it would amount to the length of a whole set of waste where there are several slashers running.

The marking motion is then turned to the right place, and the finger of the dial set at figure O.

The wraith is then adjusted so as to give a sheet of yarn equal in width to the distance between the beam flanges. This is assertained by taking alength of a warp ends and distance of the flanges measured by holding it with both the hands and then placed on the warp sheet at the wraith. If it is wider or narrower than the comb or wraith, then it should be adjusted by turning the handle. Any inequalities in the sheet must also be straightened by lifting ends

out of spaces in the wraith which may accidentally contain too many, and dividing them into the adjoining spaces which may contain too few. This is done to obtain a sheet of uniform thickness by which means the weaver's beam is made the same degree of hardness all the way across. This straightening up of the sheet should always be performed as near the bottom of a beam as possible as every end lifted over will come up crossed or out of place during the process of weaving. The sizer should also make it his duty to see that the flanges are not loose nor crooked. Because this will sink some of the ends in the side as it is being wound in layers. If this is neglected by the sizer and the he allows the yarn to be wound on the roll with the above faulty flanges then this will annoy the weaver, but it is a hinderance towards production and a loss both to the weaver and the firm or mill, as it is necessary sometimes to throw out a few ends from the sides. In case of a *Dhoty* border beam it is advisable to put four ends of grey on each side of the border adjoining the flanges from the body of the cloth and not extra ends, as each extra end means a fraction of a rupee loss to the firm, to protect the coloured ends or the border ends which are generally more expensive yarn than the yarn contained in the body of the cloth, from being damaged either by rust from the flanges or due to any other cause. The extra ends are to be included in the body of the cloth either utilising the ends for the cord or otherwise. Crowded ends near the flanges will cause a hard ridge at both the ends and this is detrimental to good weaving.

The press rollers are afterwards lifted up to the beam. Steam is then turned into the cylinders, the size and boil taps are adjusted, and the frame is run at a low speed until the cylinders get hot. If the machine be started at a high speed and the width of the yarn in the wraith is either considerably narrower or broader at one side or both, then the distance between the beam flanges ends are almost sure to be broken, or a soft side formed. By approximately adjusting the width of the yarn in the wraith, the sizer can save the weaver's endless trouble.

Defects In Sizing.

The defects which generally occur in the process of sizing are as follows :—

(1) Burning or scorching of the ends.

The fault is caused by allowing the yarn to stay on the cylinders for too long a period. It may be that the cylinders are too hot, or the machine running too quickly, or the machine

stopped to repair broken threads. In any case the yarn is overdried and when being woven it is too brittle and consequently more breakages occur besides a rough feel being given to the cloth.

> Warp over–dried cause the yarn to snap when in the loom. In order to counter act this the weaver reduces the weight on the warp, and the result is short cloth. Alternatively, the weavers place wet rags or thumbs across the warp yarn at the lease rods, and these sometimes assist the warps to weave better . If, as often happens, these rags are placed on the warp too damp, the yarn immediately commences to ball in the reed, and floaty cloth is woven.

(2) Imperfect drying or a damp sizing by which the ends stick to one another on the beam, may be due to the size mixing being unbalanced by having too much softening materials such as tallow, oil, etc. or too much salts such as chloride of magnesium or Epsom Salt, etc. in it, or to the machine running too quickly and not allowing the yarn to be dried by the cylinders, or the cylinders being too cold by insufficient steam, or through some fault with the buckets inside the cylinders not collecting the condensed water and ejecting it. Sometimes only a portion of the yarn is soft especially at one or both sides. When this occurs it may be due to bad arrangement of the steam pipes in the sow box which prevents the size from being properly boiled at either side, or the immersion roller being of uneven depth in the size, or the cylinders being hotter at one side than the other. These soft or partly soft beams cause considerable trouble in the loom and are very often so sticky that the yarn breaks. The soft size may collect in beads at the eye of the heald and after a time the beads of size break the adjacent ends when the healds work up and down. This fault may also be caused by the flannel that covers the top heavy rollers being worn all the way across or at the side or sides. It is very important for the flannel to be periodically renewed. To use it for too long a period on economical grounds is no saving because the important part that it plays in the impregnation of the size into the yarn may be lost.

(3) The shifting or transferring of ends from one dent to another should not be permitted when the beam is half or three quarter full. This should always be performed as near the bottom of the beam as possible to avoid the crossed ends.

When several threads are fastened together in the form of a piece of tape it is almost certain that some of these will break at the opening out or separating rods in the headstock and should they pass this point then the weaver has the trouble. The cause of this defect may be due to ridges in one or more of the rollers through which the yarn passes. Usually there are about the same number of threads in each dent af the wraithe and if unevenly placed, ridges may appear in the weaver's beam producing unequal tension on single threads.

(4) Surface sizing in which the size lies on the surface of the yarn and is likely to be rubbed off in the weaving, due entirely to the size being too thick and not sufficiently cooked.

(5) Hard and boardy yarn under sized yarn, soft beams, irregular or rough beams, excessive breakages of the threads, too much waste in last piece from the sizing frame or the first piece of the beam.

(6) To avoid stains on the yarn, that is, iron moulds, the barrel of the beam should be wrapped with paper, if not painted.

(7) The sizer should also see that the steam to the cylinders should be shut off about fifty yards previous to getting to the top of the beam.

(8) The tape frame should be run slowly until the yarn, which has been on the cylinders during the stoppage and thus over-dried, is wound on the weaver's beam.

(9) The weight on the friction lever should be reduced to the lowest possible working amount, or it should be pulled off altogether in case of fine counts of yarn during the time the dry yarn mentioned under paragraph 8 is winding round the beam.

The fault of soft and hard weaver's beams is due either to the friction motion or the pressure arrangement. Soft or hard beams certainly cause much inconvenience to the weaver and very often the cause of uneven cloth being woven.

(10) If the yarn comes from the slasher too stiff or too soft, it is hard to weave well; poor production and a larger proportion of fents or damaged pieces will be the result. Uniform sizing is absolutely necessary. It is a known fact that half of the weaving is done in the sizing room, for no amount of skill can produce good results from a poorly sized warp. Careless work in the sizing causes poor production and poor quality. What carding is to spinning so is sizing to Weaving.

(11) An uneven current from the fans will cause unevenly dried yarn. One fan may be running quicker than the other which sets up cross currents of air and by that means fails to cool the yarn evenly, or one or more blades of the fans may be slack causing the same effect.

(12) Attention must be paid to (*i*) bent teeth in the wraith or expansion comb at the slasher or the warping frame, (*ii*) ends broken on the back beam when slashing, (*iii*) broken ends not properly pieced or just laid on loosely at the warping frame, (*iv*) the recovery of broken ends at the slashing frame finding their way in the wrong dents of the expansion comb.

Ordinarily the rods separate each thread and when wound on to the weaver's beam are single units. Should the yarn be at all sticky the threads may be broken at the separating rods and get out of position. It is good practice to periodically pass fresh leases through the machine and get each thread passing by its correct rod.

(13) Never dilute the size in the sow-box when the yarn from the beams is being delivered, soft warp is sure to follow. Also the practice of adding water to the size mixing in the mid-feather box should under no circumstances be permitted. Because the tallow becomes solidified and swims on the surface causing the yarn to become stained with tallow or other fats or wax. The size, before it is delivered to the sow-box, should be prepared to meet the requirements and not after it has been pumped or delivered into it.

The soft warp is the jobber's and weaver's bug bear. It is not by any means always the fault of the slasher, for in some instances insufficient twist has been put into the yarn which is usually the error of an inexperienced Spinning or Weaving Master. The former runs with the idea of getting more production and the latter of getting a better cover on the cloth.

(14) Whether the squeezing roller is of the right weight for the class of goods being sized.

(15) Whether the flannel covering is soft or spongy. The covering must be firm but resillent.

(16) Whether the speed of slashing is high or low. It is generally considered that the best degree of penetration and finish is imparted to the sized yarn when the sizing speed is fairly high.

(17) For uniformity of weight the sow-box should be constantly supplied with size and not let the size in the sow-box run down and then feed it.

(18) Bad sides may be due to faulty flanges, or the wraithe which regulates the yarn to the width of the weaver's beam being incorrectly set. If set too wide the yarn becomes a greater diameter up to the flanges and either causes breakages whilst passing through the machine or comes off too slackly in the loom and cause bad sides. If the wraithe is set too narrow there is a space between the yarn and the flange and when in the loom some of the ends may fall down the space, causing breakages, with the consequent stoppage of the loom and loss of production.

Mistakes To Avoid.

(1) It is essential that the weight and feel be taken into consideration when making a mixing, otherwise it is practically impossible for sizer to obtain them.

The feeling of the yarn as it passes between the thumb and forefinger or between the third or fourth finger is the usual method of judging its dryness. The place where the test should be applied is between the draw roller and the weaver's beam.

When feeling the yarn, one of the following informations should be derived and not felt as merely from habit. If the yarn is (*a*) rightly sized, (*b*) undersized, (*c*) oversized. (*d*) overdired, (*e*) damp.

(2) Each size mixing should be uniform in strength and in the percentage of the ingredients of which it is composed.

(3) The ingredients should be treated in the same manner for every mixing and for the same sorts. Uniformity can only be maintained if proper records are kept.

(4) The size should be fed into the sow-box uniformly.

(5) The size should be well and evenly boiled. Also the maintenance of a uniform temperature in the sizing is one of the most important elements in the production of satisfactory results.

(6) The speed at which the machine is run should be regulated so as to dry the yarn uniformly.

(7) A careful examination of the boil pipes should be made periodically to see that the holes are not made up, otherwise the size will be imperfectly boiled in the proximity, and uniform boiling will be impossible.

(8) The sow-box should be perfectly cleaned out periodically, particularly where china clay mixing is in constant use.

(9) Cloth containing a large amount of unbroken starch granules will have a harsh wiry feel and a bad cover. This is very often met with where uncooked size under bad supervision is in use.

(10) The dryness or dampness of the yarn depends on the standard which experience has proved to be best adopted for it, taking the condition of the weaving shed into consideration.

(11) Uniform drying can be obtained if the speed of the machine is regulated to the pressure of steam in the cylinders.

(12) The first weaver's beam run at the beginning of a day's work is more liable to be light than any succeeding one. This is due to several causes, (2) the custom to wash the size off the copper and the immersion roller after the machine is stopped and the condensation of steam in the sow-box dilute the size in the sow box, consequently it will not only give a lower percentage of size on the first beam which goes through, but even be sufficient to reduce the adhesiveness of the size, and thus make a soft beam, unless care is taken to counteract this; (*b*) the amount of size left in the sow-box should be reduced to as small a working quantity as possible when running the last beam of a day's work. If this be done a larger amount of fresh size can be admitted into the sow-box when commencing work the following day.

(13) Pure or light sized goods must be well dried in the taping, particularly at the lower portion of the beam, otherwise they will be liable to mildew, more often than not soft warp follows.

(14) It is advisable when starting a fresh beam that the full pressure is not put on all at once on the beam. But the sizer can gradually go on increasing it as the beam is getting filled up.

This will avoid a very hard beam from being produced which is a source of not only mildew (if the yarn is sized damp), but the beam becomes unweavable owing to its difficulty of not being easily unwound on the loom.

(15) If two threads of a given count are spun, one from long and soft fibres, and another from short and harsh fibres, similar strength of size will not be equally effective on both.

(16) Hard and soft spun yarn cannot be made to absorb equal quantities of a given size. Ring spun yarn requires a stronger size than mule spun yarn, because the extra turns per inch put into the former during spinning reduces the space between the fibres of which the thread is composed, and the size mixing does not easily penetrate through. Mule yarn is more spongy than ring yarn and, on this account absorbs the size quite freely.

(17) The thickness or count of yarn, breaking strength and stretch of yarn (single thread test) play a very important part in determining the strength of the size mixing. Coarse yarns would not require so strong a mixing as finer yarns.

(18) Fineness of reed employed, number of threads drawn in a dent of the reed, and the number of picks per inch put into the cloth will determine the strength required in the size. A size mixing which would stand the fraying action of the reed and shuttle for a coarse reed and correspondingly low number of picks per inch, would be too weak for the fine reed and large number of picks per inch. Also the fewer the threads, the stronger should the size be made, as the latter runs through the space between the warp threads before the rollers act upon the yarn with the result that the yarn has not absorbed the size to the same extent as would be the case if there were a large number of ends in the set.

(19) The floor should be double-boarded with tongued and grooved thick boards of closely grained hard wood, such as, teak wood to keep the floor quite dry and warm. Flags, stone pavement, concrete and cement are most unsuitable materials for the floor of a sizing room, as they keep the temperature low, thereby causing excessive condensation of vapour.

Air of a high temperature (80° to 90° Fah.) if not too dry, imparts to the yarn a soft, supple, and mellow tone or 'feel' without leaving it dry and harsh, and also conduces to a pure and clear atmosphere with a suitable percentage of humidity. This arises from the fact that air of a higher temperature is capable of absorbing and retaining in suspension, as invisible vapour, as much greater height of water without increasing the relative degree of atmospheric humidity.

(20) Repeated boiling up with starch and flour sizes must be avoided; this treatment considerably impairs the adhesive properties.

(21) All the fittings that come in contact with the size should be of material that will not give rise to the formation of injurious substances, such as, rust verdigris, etc., in contact with moisture.

Main pipes should carry steam at full Boiler Pressure so as to utilise their full capacity, and they should be efficiently lagged to reduce heat losses. Pressure should never be reduced by partly closing a steam valve—an extremely dangerous practice.

Connections to sizing machines should be $1\frac{1}{4}''$ bore and taken off the top of the main pipe to prevent condensed water getting into the cylinders. The safety valve on the machine should be $1\frac{1}{2}''$ and of the dead weight pattern with locked cover.

(22) Of the several economic problems incidental to warp sizing by means of any of the different types of machines in vogue, the more difficult ones are those of securing. (*i*) the most effective results with the least consumption of steam for boiling the size, and also for drying the sized yarn; and (*ii*) an effective system of heating and ventilating the sizing room to ensure the best atmospheric conditions, in respect of temperature and humidity, by removing the vapour partially condensed steam that issues chiefly from the boiling size, and also from the yarn, as this is submitted, after being sized, to the process of drying. These two objects may be attained more or less succesfully only by conforming to certain conditions that are imposed by the special technical requirements of warp sizing, as regards the constructional features of the room in which that operation is conducted, as well as the position of the building in relation to the steam boiling house and other adjacement buildings.

The chief economic difficulties encountered in the operation of sizing by means of slasher sizing machines consist of an excessive condensing of steam both in the main service pipe leading from the steam boilers to the sizing department, and in the drying cylinders, with the consequent loss of heating power in those cylinders; and also of the atmosphere becoming surcharged with vapour of partially

condensed steam that lingers in the air, and thus prevents the yarn from drying sufficiently. This not only causes the warp threads to cling to each other and also to the drying cylinders, but it also conduces to the subsequent development of mildew in cloth.

The actual consumption of steam for sizing (drying and boiling), and also the relative cost of producing it will, of course, vary considerably, even during equal specified periods, not only in different weaving mills, but also in the same mill, according to the relative proximity of the sizing department and steam boilers; the structural features of the sizing department, the type of steam boilers, the type and dimensions of the drying cylinders—that is, whether they are of the usual 'drum' or of the 'cavity' type; the fluctuation in the price of coal; the different varieties of warp to be sized; the character and grade of sizing, and many other varying factors.

Power=4 I.H.P. approximately for a 9/8s slasher machine.

Speed=160 to 210 R.P.M.

Production=Should be based on actual data relating to specified classes of work being produced. But an average of 25 yards per minute should be considered very reasonable.

Ratio of one sizing machine to looms=250,—width ranging from 38″ to 50″ of cloth—average picks 48 per inch medium counts.

200 looms to one sizing machine—width of cloth 38″ to 50″—average picks per inch 36 medium counts.

90 to 100 looms to one sizing machine,—width of cloth 23″ to 60″—average picks per inch 32 medium counts.

90 looms to one sizing machine—if all the looms 23″ to 60″—av. picks per inch 36 medium counts, are working on Dhoties and Sarees, plain and fancy borders with numerous patterns, that is 7 to 10 patterns per bundle of 10 pairs each. Borders ranging from $\frac{1}{8}$″ to 3″.

Waste=.10 to .15 per cent according to class of work.

Depreciation=6 per cent. per annum, including the cost of general repairs, renewing cylinders, oil, belting, etc.

CALCULATIONS.

Q. How would you find the speed of a drag roller on a sizing machine ?

Rule ;—Revolution of line shaft × drum on it × speed wheel ÷ drag roller wheel × pulley on the tape frame.

Example ;—If the revolution of line shaft be 77 per min. the drum on it $22\frac{1}{2}$ inches driving the tape pulley 13 inches and if the speed wheel be 12 and drag roller wheel 100, find the speed of the drag roller.

A. $\dfrac{77 \times 22.5 \times 12}{100 \times 13} = 16$ revs. per minute.

Q. Find the number of yards per min. delivered by the drag roller on a tape frame.

Rule ;—Revolution of drag roller × circumference of drag roller ÷ 36.

Example;—If the speed of the drag roller be 16 per min, and its circumference be $29\frac{1}{4}''$, find the number of yards per minute delivered.

A. $\dfrac{16 \times 29.25}{36} = 13$ yards per minute.

SIZING DEPARTMENT
MACHINERY DATA.

Kind of Machine	Date and Maker.		No. of Frames	Speed of Line Shaft.	Pulleys.		Speed of Frame	Average per day of 9 hrs.	Remarks.
	D.	M.			Driver.	Driven.			
9/8's	1924	H.B.	1	160	17	14	194	11000 to 13500 yds.	Production depends on quality of yarn, counts of yarn and size %
9/8's	1924	,,	2	160	17	14	194		
9/8's	1924	,,	3	160	17	14	194		
9/8's	1924	,,	4	160	17	14	194		
9/4's	1924	,,	5	160	17	14	194		
6/4's	1924	,,	6	160	17	14	194		
7/4's	1924	,,	7	160	17	14	194		

Hands Employed.

Designation.	No. of Hands.	Amount. Rs.	As.	Per.	Remarks.
Sizer	7	33	0	M.	
Back sizer ..	7	21	0	,,	
Beam carrier ..	4	10	0	,,	For creeling and weighing sized beam.
Sizing Mistry ..	1	40	0	,,	
,, Fitter ..	1	50	0	,,	Also attends winding and warping Depts.

Sizing Department

Stores Consumed. *

Description.	Quantity. Lbs.	No.	Per.	Remarks.
A. M. Oil ..	10		W.	
Flannel		10 yards.	,,	
Marking Blue. ..	1		,,	
Brown Paper ..		10 Reams.	,,	
Emery		6 only.	,,	
Laces	1		,,	

* Details of stores consumed etc. depends upon the quality of the articles and supervision and what is given here is for a guide and an idea only.

DETAILS OF SIZE MIXING BECKS.

On the first story of the size mixing department the flour becks and clay pan are placed. On the ground floor, the finishing or mixing becks and tanks for chlorides of zinc and Magnesuim are placed.

No. of Beck.	Dimension of Beck. L	B	H	Cubical Contents Gallons	Speed of Line. Shaft.	Pulleys Driver	Pulleys Driven	Speed	Bevel Wheels. Driver	Bevel Wheels. Driven	Speed of agitator	Description.
5	8	4	4	800	92	12	12	92	19	46	38	Square Flour Becks.
	Dia.	B.B.D										
3	3′-6″	3′-6″	3′-7″	215.43	92	12	12	92	20	·46	40	Circular clay Pan
3	4′-8″	4′-0″	3′-11″	363	92	12	12	92	18	46	36	Circular Finishing Beck.
2	8	4	4	800	92	12	12	92	18	46	36	Finishing Beck

Hands Employed.

Description.	No. of Hands	Amount. Rs.	As.	Per.	Remarks.
Mistry	1	30	0	Month	
Coolie	1	18	0	,,	
,, ...	1	15	0	,,	

Stores Consumed.

Description.	Quantity. Lbs.	No.	Per.	Remarks.
Wheat Flour ..			Month	Consumption depends on size of mill, class of goods manufactured & size % put on yarn.
Ch. of Zinc ..			,,	
Ch. of Magnesium ..			,,	
Tallow			,,	
China Clay ..			,,	
Brooms		2	,,	
Spindle Oil.. ..	2		,,	
Emery Paper ..		6	,,	

Dimension of Sizing Room.

Size of Room. L.	B.	H.	Doors. No.	Size.	Windows. No.	Size.	Skylights. No.	Size.	Remarks.
60′	110′	12′–6″	2	9′–3″ × 7′–6″	4	7′ × 7′	2	10′ × 10′	

Dimension of Size Mixing Room.

Size of Room. L.	B.	H.	Doors. No.	Size.	Windows. No.	Size.	Skylights. No.	Size.	Remarks.
60′	40′	12′–0″	1	6′–6″ × 7′–6″	4	3′–6″ × 2′–0″	Nil.		

CHAPTER XXVII.

SIZING INGREDIENTS.

Wheat Flour.

From the public records that are available from the 17th century it will be seen that while there is no indication of the use of rice (commonly believed to be the first ingredient used in the East in the earliest days of cotton—cloth production); wheat flour had a monopoly till 1794, when potato flour (the term farina does not appear to have been general till 1842) was suggested, and it was recommended that it be mixed in the proportion of 6 to 1 with air-slacked lime.

The substances present in wheat flour are found to be considerably dependent upon several very important factors :—

(1) the kind of grain used as seed ;
(2) the condition under which it is grown ;
(3) the locality in which it is raised ;
(4) the method of milling ;
(5) the dealer through whose hands it passes ;
(6) specially prepared by blending a number of varieties of wheat.

Flour is still a very important sizing ingredient and is nearly always used alone or in conjunction with other starches, when it is desired to add weight and body to the yarn. Before used it must be prepared which is done by fermention or steeping, after mixing it with an equal quantity of water and the required quantity of chloride of zinc.

The author can safely assert that there is nothing better than flour for Medium and Heavy Sizing for both good results such as fullness and feel of cloth and as well as of cheapness of mixing. If mixed with well known starches in small proportions it will help towards better weaving and a peculiar mellow feel which at times is necessary for certain class of goods.

The two substances that definetly affect the character of the size are the qualities of Flour and China Clay. It has happened many a time when a sizing or weaving master leaves one mill to go to another mill gets perplexed when he fails to obtain the same result that he had obtained in the former mill though the proportions of size mixing that he has used was the same in both the mills. The reason of failure is definitely due to the quality of the ingredients used in either of the mills.

The principal constituents of wheat flour are :—

Starch and Gluten.

Flour is used in size chiefly as an adhesive, and besides starch it contains another constituent which is still more adhesive. This is termed gluten, and the value of flour for sizing purposes is largely determined by the quantity and quality of the gluten present.

As a great deal of gluten is often lost in fermentation, the quality is of more importance than the quantity. This must be tested when moist after washing away the starch. It should be tough, tenacious,and elastic.

Starch and gluten exist in varying proportions according to the quality of flour, and range approximately from to 60 to 70 per cent of starch and from 3 to 15 per cent of gluten (occasionally up to 20 per cent), a good average being 9 to 10 per cent.

Protein In Flour.

Protein is an organic substance easily attacked by bacteria causing rapid fermentation.

Gluten.

Gluten is a very strong adhesive, and if large quantities of china clay are to be used for weighing purposes, a flour with an abundance of gluten becomes desirable. If wheat flour and water are combined in suitable proportions, and the mixture heated to about 180° Fah. (82°C.) the starch and gluten combine to produce an adhesive paste of great binding and fixing power. Some flour may contain to the extend of 8½ per cent of gluten.

Higher grade or patent flours contain a less percentage of gluten than the lower grade flours, but the gluten in the former is usually of better quality.

The presence of gluten in flour used for sizing is condemned by some authorities because of its marked tendency to develop quickly a state of septic or putrefactive decomposition, during which it emits a peculiarly sour and offensive odour.

Under certain favourable conditions of exposure to a warm, moist, and ill-ventilated atmosphere, flour is liable to foster the germination and development of several species of both animal and vegetable microbes, some of which are inherent to the flour itself, whilst others are deposited from the atmosphere, and find in flour a favourable fertilising medium.

The elimination of nitrogenous substances containing the fermentative and putrefactive principles makes pure starch much less liable to mildew or other organic decomposition.

Starch may be mixed with water and boiled immediately ready for use. Whereas flour is usually steeped in cold water for a period varying from two or three days to as many weeks. The chief object of steeping flour is to promote the action of fermentation with a view to neutralising the septic principles inherent to the nitrogenous constituents of flour, thereby reducing the tedency of the gluten to develop a state of decomposition as mildew.

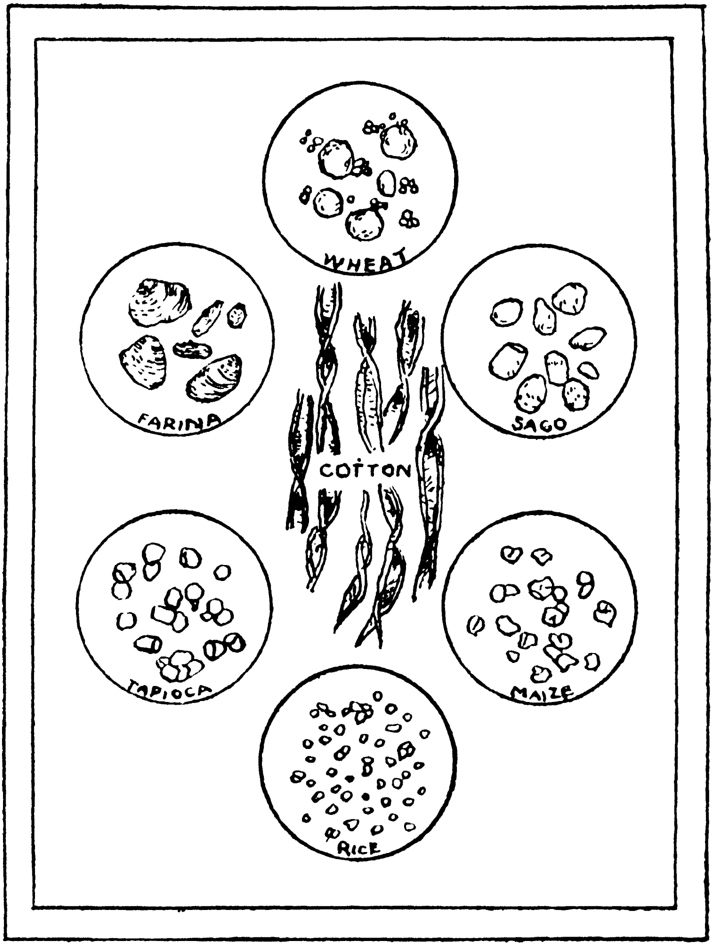
Fermented flour is said to impart to the yarn and cloth bo h a soft and mellow feel when handled, and also a better tone of colour.

It may be added that there is very little advantage except that of price in using any particular kind of starch. At a moderately high temperature starch is converted into dextrine.

If sta ch be boiled with an equal quantity of water, whe.t starch gives a thinner but more adhesive paste than potato starch, and least adhesive of all starch paste is that prepared from rice starch.

Starch.

This in its pure state is a white tasteless powder. It is insoluble in water, cold or hot. When boiled with water the granules of starch swell to a very great extent and then burst and become gelatinized. It is a naturally produced body, and hence it has a structure. Under the microscope this is very apparent and is found to be granular.



MICROSCOPIC DRAWINGS.
OF
STARCHES ETC.

The granules of wheaten Starch are composed of large and small corpuscles. The smaller ones are generally round, and provided with the dark central spot or hilum; the large granules being rounded and flattened.

Again starches produced by different varieties of vegetable tissues are found to exhibit different granular structures.

Boiling in water, or the use of certain chemicals, destroys this structure by destroying the outer coating of the granule, which is considered to be a form of starch cellulose and which does not

produce a blue colour with iodine. Starch has no adhesive qualities until this coating is destroyed. Hence the need for boiling or other treatment to make the starch paste.

Quality of Flour.

Owing to the prominence and good name of flour as an ingredient for sizing, it suffers a great deal from adulteration of various kinds, the principal being very inferior flours, starches and mineral matters.

An easy method of testing the quality of flour is by mixing a small quantity with two or three drops of strong nitric acid and allowing it to stand for a few minutes on a white porcelain lid. The resulting colour would be deep yellow if the flour is pure but becomes a greyish white translucent mass if mixed with, or is containing, an excessive amount of starch.

That flour contains starch is proved easily by the iodine test. Boil a little flour and water and cool it by pouring into a jar of cold water. Add two or three drops of tincture of iodine and a deep blue coloration is produced.

N. B.—This colour is destroyed by heating or by the addition of caustic soda. Therefore the emulsion must be acid or neutral and cold before the iodine is added. Alkalinity should be neutralized by the addition of acetic acid. The correct estimation of the amount of starch in flour is too long and difficult, but an approximate method is to knead 10 grams of flour in a muslin bag, held in a beaker of water, until all the starch is washed out; allow the starch to settle, pour off the clear water, dry and weigh the sediment.

Albumen.

The albumen found in flour is soluble in water. The Soluble Albuminoid in wheat flour which equals to about $1\frac{1}{2}$ per cent is a nitrogenous substance easily attacked by bacteria and when the size is boiled, become coagulated and precipitated and serves no purpose except as an agent for developing mildew.

Gluten.

Weigh carefully a certain quantity of flour say 15 grams Add a few drops of water, drop by drop, until a paste is formed which at the same time does not appear wet. This paste is then placed in a fine cotton muslin bag. Let water in a small stream be directed

upon. it. At first the water, as it percolates through the cloth, assumes a milky appearance. As the filtrate passes off clear the mass remaining agglutinates into a compact body or a solid mass which is known as gluten.

If they are small separate lumps, or if any of it has passed through the fabric of the bag and is seen to be clinging to the outer surface, the gluten can be regarded as of poor quality. Carefully collect all the gluten from the bag and roll it between the hands until it has a tendency to adhere thereto, showing that excess moisture has been removed.

Whilst the washed gluten is still wet it should be stretched, and the distance it stretches noticed, as this will give the quality. Good gluten will stretch about an inch before breaking. The gluten that stretches most is the best for sizing purposes.

Percentage of Gluten.

Carefully weigh the gluten and estimate the percentage as follows :—

Weight of flour = 15 grams.
" " gluten = 3.75 "
Divide the weight of wet gluten by 2.61
$3.75 \div 2.61 = 1.438$ gram.

$$\text{The percentage of dry gluten} = \frac{1.438 \times 100}{15} = 9.58\%.$$

The percentage of gluten varies from 8 to 15 per cent. Gluten exists in flour as a dry powder, and it is only after the addition of water that it swells up into a tough elastic mass.

The nature of the gluten will in all cases furnish useful indications with regard to the quality of the flour. The more tractable it is the more elastic, tenacious ductile homogeneous, and free from a bad smell and brown colour the more probable it is that the flour, from which it proceeds is of good quality.

Sugar.

This is also a natural constituent of flour and is known as glucose.

The Dextrine and sugars present in wheat flour are useful in their properties as sizing agents and equals about 3½ per cent. But the percentage varies from one batch to another.

Mineral Matter.

This is present in all flours, and is the substance left over as ash when flour has been burnt.

Water,

It is always present to the extent of 12 to 14%.

Colour of Flour,

Flour is chemically treated to make it white, but the whitening agents must be known, and, as they will not all stand boiling, it stands to reason that a test must be taken both from dry and boiled wet flour.

A good flour should not be of a dark shade, but be white, sweet, free from any bad odour and acidity, as this affects the colour of the cloth.

The flour should handle dry, fine-grained velvety or dust-like—never damp, sticky or greasy. When rubbed between the fingers it should crumble down still finer, and leave smooth surface that can be dissipated by gentle blowing. The smell should be fresh and not fusty, musty, or objectionable. When placed in cold water good flour should soak easily without sinking in the form of lumps, and should give a milky fluid when stirred up in water, the flour settling down again slowly afterwards leaving the water as clear as it was before. Compare the unknown flour with a standard flour known to be of good quality. The best method is to place a small quantity of each side by side and press them down with some flat intrument or a sheet of black glazed paper. Or, take a small quantity of the sample and of the standard, and spread out with a thin knife one over the other, and, where the edges overlap, the slightest difference in the colour will be noticed very plainly. The standard samples should be kept in closely stoppered bottles, and, if they suffer from the effects of light, keep them from the light, but all of them should be kept from air.

Another easy test is to make up the sample to a paste with water and do the same with another flour of known quality leaving the two under identical conditions, until fermentation sets in. The one fermenting first will be the older, damper, and less pure specimen. A good flour will require thirty per cent more water in the preparation of the dough than inferior.

Boiling Test for Colour.

Take an equal quantity of both sample and standard, mix each with an equal quantity of water, then boil separately. After boiling place each in a test tube, allow to cool, and then, if there is any difference in colour, it will be visible. Boil the samples to a thick paste by taking an equal quantity of each and observe the stiffness of paste and colour after allowing them to stand for a little while.

Adulterations of Flour.

Wheaten flour may be adulterated by such mineral substances as china clay and plaster of paris, or some cheaper starch. Flour free from adulteration should not contain more than one per cent of ash as the maximum.

To Test for Rice Flour.

If flour is adulterated with rice flour, a peculiar kind of crispness is noticed, and, as rice is frequently used as an adulterant, it is well to note this test.

To Test for Mineral Matter.

Pure flour will float on the surface of chloroform since this liquid is heavier than water. Mineral matter, such as china clay, will not float being heavier than chloroform. If a little of the flour is added to a test tube containing chloroform, shaken up, and then allowed to stand for some hours, any mineral matter present in the flour will be clearly seen at the bottom of the test-tube.

An easy method of testing the quality of flour is by mixing a small quantity with strong nitric acid and allowing it to stand for a few minutes. The resulting colour would be deep yellow if the flour is pure, but remain unaltered if mixed or containing an excessive amount of starch.

Microscopic Test.

One of the best tests is the microscopic test, as the various particles that make up wheat flour, and those that make up other flours, are so dissimilar that they can very easily be detected.

Moisture in Flour.

Moisture is about 13 per cent, although the conditions of storage can alter this figure considerably. A test should always be made for moisture in flour and it should be very carefully performed as flour takes up moisture very quickly from the air, thus any carelessness will give incorrect results. Weigh a sample, dry in an oven until its weight remains constant or for a few hours, weigh after it is cooled down. Note the loss in weight. Use two watch glasses and a clip for the purpose.

Damaged Flour.

Damaged flour often contains minute insects that feed upon the best sizing part of the flour, and, as flour in a mill is frequently kept in a warm, moist atmosphere or in a damp place these conditions will help forward the growth of any insect life already in the flour. These insects are invariably found near the top of a sack, as they require air, so that, by taking a small sample from the top of the sack, and laying it down on some flat surface, and carefully smoothing over the top so as to leave a perfectly smooth surface, and leaving for a short time, if any insects are present they will begin to move about, and thus break the smoothness of the surface.

To Test for Ash.

Weigh a given sample, ignite in a crucible until the flour is reduced to ash after about two hours heating, cool and weigh and calculate the percentage in the ordinary way. Ash should not exceed 0.9 per cent. and it may be as low as 0.4 per cent. a good average being 0.5 to 0.6 per cent. Ash or mineral matter are impurities and should be reckoned as dead loss.

Test for Consistency.

Mix 10 oz. of water with 1 oz. of flour, and boil for 25 minutes, pour into a glass and allow to stand 6 hours. Float or place a small tin box on top of the mixture, and add small lead pellets, one by one, until the top of the mixture is broken. Similarly other samples of flour should be tested simultaneously.

Another way of testing for consistency of flour is to take 1 oz. of flour and add to it 10 oz. of water. Boil for about 20 minutes. Pour into a glass and allow to stand for about 6 hours. Suspend a

pointer above the mixture, liberate it suddenly and notice how far it penetrates into the paste. Similarly other samples of flour should be tested.

Strength of Paste.

Mix an accurately weighed quantity of each sample of flour with an equally carefully measured volume of water which should be brought to a boil before adding the flour. Leave these mixings to stand overnight, and then test the unknown flour with the known flour by gently pressing between the fingers.

In a doughy state its particles should stretch considerably without becoming separated, and it should always have a clear appearance, be uniform throughout and should feel gummy when felt with by fingers. If it seems dark and cloudy it should not be used, as this shade will be communicated to the yarn.

Should size, during the course of manufacturing, not behave in the usual way or in the event of not giving the anticipated results, recourse should be at once had to the flour, which should be carefully examined and, if necessary, chemically tested.

If either quantity or quality of the essential elements to make good size is not present, the size will not do the work expected from it. This will result in bad work, annoyance, and loss.

Another valuable test to apply to flour is to add to 20 grams of flour a mixture of 70 c.c. of absolute alcohol, 25 c.c. of water and 5 c.c. of strong hydrochloric acid. Put it in a large tube and digest in a beaker o' hot water for some time. Allow it to stand to cool for an hour. Examine the appearance at the end of that time. If the liquid is—

(1) perfectly colourless, it is pure wheat flour;
(2) blood-red, it contains ergot;
(3) purple red, it contains mildew;
(4) yellow, it contains barley or oat flour;
(5) orange-yellow, it contains pea flour.

Dextrine.—$C_6 H_{10} O_5$

It is soluble in cold water. Dextrine is a variety of soluble starch of greater solubility and is obtained in the form o' a fine dry powder varying from a white to a faint brown tone. It is manufactured from ordinary starch either by heating at a temperature of about 302° F. to 320° F. (150° to 160° C.).

If a little water is mixed with flour and the liqu d then filtered off, some idea of amount of dextrine present can be obtained by adding a few drops of solution of iodine to the liquid. This will act on the dextrine and produce a purple coloration which will vary according to the amount of dextrine present.

Test for Water.

Weigh two grams into a tared shallow tin tray, about 2 in. square by ¼ in. deep, place in a water oven for two hours, cool in a desicator and weigh.

Test for Starch.

Iodine has the property of colouring starch a beautiful indigo blue. This colour is destroyed on boiling. In testing for the presence of starch, the substance under examination should first be boiled with water, then allowed to cool, and a solution of iodine added. The colour is not produced in the presence of free alkali, and if this be present it must be neutralised with acetic acid. In the presence of free mineral acid, and oxalic acid, the boiling must not be too prolonged, otherwise the starch will be converted into sugar and so remain undetected.

Test for Starch and Dextrose.

Mix two grams with a little cold water in a beaker till free from lumps, rinse into 100 c.c. graduated stoppered cylinder with water at about 30°c (cold water may be used), fill up exactly to the mark, shake occassionally for an hour, adjust the volume again, shake and allow to stand for about twenty—four hours. Should any starch tend to float, or adhere to the upper portion of the cylinder, a careful agitation of the upper part of the liquid will assist it to subside. This operation is quite simple, though difficult to describe. After twenty-four hours settlement the starch should form a compact layer of only about two or three c.c. at the bottom of the cylinder. With a 100 c.c. pipette having a stern which will reach down to the five c.c. mark, carefully withdraw as much of the supernatent liquor as possible without disturbing the starch (about 95 c.c.). This is best accomplished by having a rubber tube, about 2ft. long and say 3/16 in. internal diameter, attached to the top stem of the pipette, so that the jet can be watched and moved downwards during the operation (the solution will be required for dextrose estimation as described below).

Refill the cylinder with cold water, shake, and again allow to settle overnight. Again withdraw about 95 c.c. of the clear liquor, refill again with water, shake, allow to settle a third time, and withdraw 95 c.c. again. Now rinse the starch into a tared silica or platinum dish, preferably with industrial methylated spirit. Evaporate to dryness on a steam hole, taking care that it does not spit. It is advisable to have the water in the bath boiling only gently. Dry the starch in a water or steam oven till constant in weight, this giving starch on two grams of the sample.

Dextrose.—Measure, with a pipette, 50 c.c. of the first extract (equivalent to one gram of the sample), into a 250 c.c. conical flask, add 50 c.c. mixed Fehling's solution (the "B" solution should contain only 100 grams of caustic soda per litre), place over a bunsen so regulated that boiling commences in from three to four minutes. This is important, and a suitable size of flame should be first ascertained by trial with 100 c.c. of water. Boil gently for exactly two minutes and filter quickly through a nine cm. Swedish No. 1 F paper. The filter must not be allowed to run dry and should be kept as nearly full as possible. Still keeping the paper well filled, rinse the precipitate into it with very hot water, and continue the washing until 200 c.c. of water has been used. It is a good plan to transfer the funnel to a 200 c.c. flask when washing commences, and continue till the flask is full. Remove the filter paper and fold so that the precipitate is well inside, place it in a No. 1 porcelain crucible, heat gently till the paper is dry, raise the flame till the paper ignites, reduce till it ceases to flame, and then increase to full redness till, after cooling in a desiccator, the weight is constant. A half hour ignition in the first place will generally be sufficient.

Carry out a blank experiment using 50 c.c. of Fehling with 50 c.c. of water, and deduct the weight of CuO thus obtained from that obtained from the dextrose solution. The corrected weight represents CuO equivalent to dextrose in one gram of the sample. The weight of CuO multiplied by 0.8995 gives the equivalent in terms of Cu_2O, and the dextrose corresponding to this may be found from Munson and Walker's tables. For all practical purposes, however, the dextrose can be calculated direct from the CuO (as weighed) by multiplying with a factor ascertained from the following table, which is based on Munson and Walker's figures. Factors for intermediate weights can be obtained by interpolation.

Milligrams of CuO	Factor	Milligrams of CuO	Factor
10	.360	100	.3875
15	.368	150	.3928
20	.372	200	.3980
30	.377	250	.4030
40	.380	300	.4080
50	.382	350	.4133
60	.3835	400	.4187
70	.3845	450	.4244
80	.3855	500	.4303
90	.3865		

Dextrine.—The water, ash, starch, and dextrose, deducted from 100, gives dextrine.

RAPID FILTRATION

NOTE.—It is very desirable that the filtration should be rapid, and this necessitates the use of a well chosen funnel. and careful fitting of the paper. A 2 in. funnel with a parallel bore stem about 3/16 in. internal diameter is suitable. The filter paper should be folded at such an angle that its upper edge can be fitted closely to the funnel without forcing into the apex of the funnel. It should be wetted with hot water and the upper edge pressed into perfect contact with the funnel without forcing downwards into the cone. Hot water should then be run into the paper until the stem is completely filled. without any air bubbles either in the stem or behind the paper. A little manoeuvring of the funnel may be needed to accomplish this. If all is satisfactory the column of water should be retained in the stem, and when hot water is run into the paper it should run through in a continuous stream. With a well fitted paper in a good funnel. the filtration of the Fehling precipitate, and 200 c.c. washing, should be complete in from five to seven minutes.

Clearness of solution.—Three grams of a high grade dextrine. mixed with 50 c.c. of water and heated in a water bath for five minutes, should give an almost perfectly clear solution. and there should be not more than a slight opalescence after standing overnight.

It is used more for the finishing process than warp sizing. Being soluble they form a thin liquid. When boiled with water which penetrate the fibres of the cloth, instead of remaining on the surface

only, as is with starch, these substances produce a thick firm feel in cloth finished with them. They also have the property of causing starch to boil thinner than when this substance is boiled with water alone. This is an advantage when it is required to give a thick leathery feel to low class cloth in which china clay is not used.

ANALYSIS OF WHEAT.

Water	13.56%
Proteins	12.42 ,,
Fat	1.70 ,,
Starch	64.07 ,,
Sugar	1.44 ,,
Gums and Dextrine	2.38 ,,
Fibre	2.62 ,,
Ash	1.79 ,,
	99.98 ,,

ANALYSIS OF WHEAT FLOUR.

	A.	B.	C.	D.
Starch	68.2	70	67.5	64.07
Gluten	9.8	6.8	2.28	14.12
Dextrine	3.54	4.2	7.37	5.00
Glucose	4.87	5.16	8.58	1.44
Mineral matter	.80	.65	.51	1.79
Water	12.79	13.19	13.78	13.56
	100%	100%	100%	100%

CHEMICAL TEST OF WHEAT FLOUR

Test.	Pure wheat Flour	Starch.	Mineral Adulterant
Shake in tube with dry chloroform	Rice to top		Settle to bottom.
12% Solution of Potash.	Dissolve		Does not dissolve
Nitric Acid	Yellow orange	white mass	
Ammonia	yellow.	Bean starch turns dark brown	
Hydrochloric acid.	Deep Violet		

In the three branches of sizing which are commonly recognized—i.e., (1) for weaving or pure, (2) medium sizing, (3) heavy sizing. There must of necessity be considerable variation in ingredients, quantities, and mixings; but there are certain essentials common to all, and one of these is an efficient and cheap adhesive. Formerly it was in the largest measure prepared from wheat flour by the process of long fermentation. To-day that method is to all intents and purpose extinct.

Steeped Flour.

There are two methods of preparing flour for sizing, one preparation being known as steeped flour and the other as fermented flour.

The flour is more commonly steeped now than fermented. The advantages claimed by this method are as follows -:—

(*a*) That the gluten is retained and fully recovered when the mixing is boiled to a temperature of 212° Fah. or 100°C. Gluten helps to fix the china clay thus imparting to the cloth fulness and body, by cementing the size to the yarn.

(*b*) There is no risk of loss in steeping with chlorides through the contents of the beck overflowing, as often occurs during the process of fermentation because no gas is liberated by this method.

(*c*) It prevents in the most effective manner any development of mildew growths by stopping at once and putrification being set up in the raw gelatinous matter.

(*d*) Fewer becks and much less flour is required to be kept under water with as good a result as aged for 3 months.

(*e*) There is less risk of the chloride of zinc and magnesium being forgotten from any mixing if it is put down with the flour in the first instance. If antiseptic be partially mixed with flour and partially mixed with the other ingredients before adding to the flour in the finishing beck or the clay pan, they are weakened, as it is considerably diluted before mixing with the flour. It is better to mix the full quantity of antiseptic with the flour so that it will attack the tendency to mildew at full strength.

(*f*) Greater uniformity in heavy size mixings is obtained by the use of flour which has been steeped with chloride of zinc than by the use of fermented flour.

(*g*) The steeped flour if used for coloured goods will give it a better feel and face to the cloth than fermented flour.

Fermented Flour.

When it is required to prepare flour by fermentation, the size mixer or the sizing master should see that the beck is perfectly clean. If necessary, the beck should be scrubbed out with boiling water and washing soda. The required amount of water is then run into the beck and the flour added, the dashers beig in motion during the mixing. This mixture is then allowed to stand for upwards of three months, usually about 4 months.

It is difficult to specify the time required for the fermentation of the various kinds of flour owing to the differences in the content of gluten, albuminoids and fermentative organisms, and also the divergence in local conditions. Hence a little experience is evidently required before the operation can be properly supervised and controlled.

Care should be taken to leave the level of the mixture sufficiently low to allow for the swelling due to fermentation ; otherwise the flour may run over the top of the beck.

In the process of fermentation the gluten in the flour is destroyed leaving almost pure starch, and mildew is prevented by antiseptics which are produced in the flour itself by continued fermentation.

Fermented flour is not by any means a superior strong adhesive although as much as 30% can be added to yarn by using only fermented flour and tallow. It has more penetrating properties than the steeped one.

Fermented flour is used only for pure sizing, and where zinc is undesirable a softer feel is obtained by treating flour in this manner, but it is questionable whether the difference in feel compared with that of steeped flour warrants the expense of having large quantities laying idle in a mill added to which is the total loss of gluten in the flour.

When flour is fermented, acids are formed which modify the starch content into semi—soluble form. This produces the soft feel characteristic of fermented flour, but when starch is made soluble it loses its adhesive properties and only tends to thin the size and as a sizing agent is of very little importance.

The acids formed by fermentation are acetic and lactic acid which are useless for sizing, but are known to have very harmful effects on healds and reeds. These acids develop to the extent of of 1 per cent.

The acidity in the flour can be tested by a piece of blue litmus paper in the mixture. If acid is present the paper will turn red. When this is the case the acid should be carefully neutralized by adding caustic soda or soda ash mixed in water, and the mixture again tested with litmus paper. This process should be carried on with great care until no further change in colour of the paper takes place. Acid in flour tends to cause mildew, and has a corrosive effect on the copper rollers of the sizing frame.

If caustic soda or caustic potash is used as an alkali to neutralize the acids and if Magnesium chloride is used in the size, the caustic will decompose the Magnesium Chloride.

Flour that is intended to ferment should be specially selected. A flour with high percentage of starch and a low percentage of gluten would be more desirable, and would cost less.

Dressing of Flour.

Ordinary flour is generally dressed through No. 10 Silk having 100 meshes to the inch. Flour that has been dressed through No. 16 silk having 160 meshes to the inch is best for sizing as it will contain more starch and less gluten. To get more whiteness grind the wheat through A, B, and C rollers only. The more than flour is passed through grinding rollers the darker it becomes. Sometimes the flour is electrically treated to make it whiter.

Details of Steeping Flour Vat.

The size of the steeping beck $=8'$-$4'' \times 4' \times 4'$, length $\times$ breadth $\times$ depth.

The beck to be divided into five marks or in other words to hold sufficient flour for five mixings.

Assuming that the proportion of flour in a given recipe is 690 pounds $\therefore$ the quantity of flour for 5 mixings will be $690 \times 5 = 3450$lbs.

Depth of beck $=48''$, allow one inch from the bottom of the beck to the centre of the delivery valve.

$\therefore \quad 48''-1''=47''$

Now allow $7''$ from the top of the beck for overflowing, etc.

$\therefore 47''-7''=40''$

$40'' \div 5''$ (marks or mixings) $=8''$ to one mark or mixing.

Eight inches apart will be each mark indicated by a piece of wood 3″ long by 1″ broad by ½″ thick screwed in the centre of the beck on the inner side.

The cubical contents of the beck =8′-4″ × 4′ × 4′

$$\frac{25}{3} \times 4' \times 4' = \frac{400}{3} = 133\tfrac{1}{3}\text{c. ft.}$$

133.33 × 6.25 (gals. of water to 1c. ft.) = 833.31 gals. app: in 48″ 833.31 ÷ 48″ = 17.36 gals. to one inch allow .11 for agitators and the four corners of the beck ∴ 17.36 − ·11 = 17.25 galls. to one inch practically.

40″ × 17.25 (galls. to 1 inch) = 690 Galls. 690 × 10 = 6900 pounds of water.

Weight of flour for five mixings = 3450 lbs; 6900 ÷ 3450 = 2 i.e. 1 part of flour to 2 parts of water.

Having thus marked or divided the beck then take pure water up to one or two marks.

Add 34 pounds of washing soda at the rate of one per cent on the weight of flour. Stir for a little while.

Add 8 to 16 pounds of hydrosulphite at the rate of ¼ to ½% on the weight of flour for the purpose of whitening the flour.

Add the full quantity of chloride of zinc that would be required for the five mixings. Agitate for a little while and thereafter introduce the full quantity of chloride of magnesium in liquid form that would be required for the five mixings.

Admit now the wheat flour bag by bag allowing a sufficient interval for mixing the flour thoroughly until the full number of bags are exhausted perhaps in a couple of days.

Each succeeding day the mixture lacks thinner and in a week presents a limpid appearance and splashes about the beck like thick cream when the agitators are working.

Let the agitators keep constantly going at half the speed so long the mill is working and let the flour be steeped about 10 days.

Penetrating Power of Starches.

Starch is the most important substance used in sizing and for giving adhesive properties to the size and strength to the yarn.

The penetrating power of the starches in use is in the order of Rice, Wheat, Corn, and Potato.

Coating power of starches in use is in the order of wheat, rice, corn and potato.

The bigger the swollen granules of a starch the lesser the penetrating and coating as in the case of potato starch and therefore lesser is the stiffening.

Penetrating and coating is related to the size of the swollen starch granule and stiffening depends on the amount of penetration or coating of a starch on the yarn or a fabric.

Wheaten starch gives smooth and thick feel to the cloth sized with it. If too much is used in a mixing it will make the yarn very hard and wiry and hence unless the humidity is so regulated, excessive breakages must follow. Wheaten starch takes a high gloss on calendering. On account of its powerful and adhesive qualities also acts as a good carrier for china clay and other weighting substances.

Starch, Clay and Metallic salts relate to percentages, and the finish. A particular percentage may be obtained by varying the proportion of clay and metallic salts.

Test for Starch.

Boiled with water, cooled, neutralized with acetic acid (if alkaline) and then tincture of iodine added, a violet blue colour is obtained.

Nitric Acid Test for Starch.

A test that can readily be applied is the Nitric Acid test. Place about 15 grains of each sample in separate test tube, add to each a sufficient quantity of Nitric Acid (Strong) to make a paste. The sample that changes its colour least has the most starch in it, and the sample that assumes a deep yellow colour contains little or no starch and only pure wheaten flour.

Penetrating Agents in Sizing.

Perminal W is of particular interest as a penetrating agent in sizing, since the viscosity of starch mixture can be quite considerably reduced by incorporation of Perminal W into the mixture. This addition of Perminal W produces a thinner and more workable liquor, gives more uniform application of size to the yarn and better penetration of size into the yarn and also lowers the starch usage.

Cellofas WLD.

This product is cellulos derivative recently introduced into the market which is finding use as a sizing agent. Its properties are superior to those of starch in that its solutions are neutral and very resistant to the action of light, alkalies and atmospheric oxidation. In addition, its solutions do not ferment or become acid on standing. The binding properties of Cellofas WLD are very much superior to those of starch. The product can, therefore, carry a much greater proportion of filler than can be applied satisfactorily to yarns or fabrics from a starch mixture.

Cotton or rayon yarns may he sized by application of 1 to 2 % solution of Cellofas WLD. This gives a full but tough and supple sizing effect. If it is not wished to use Cellofas WLD. alone for sizing, a portion of the flour or starch normally used may be replaced by Cellofas WLD. This results in a reduction in flaking troubles and dusting and improves the weaving properties of the yarn.

The following recommendations are made for the preparation of solutions of Cellofas WLD, the product being soluble in cold water but not in hot water.

Five parts of Cellofas WLD are wetted out by stirring with 45 parts of water at or near the boil. This mixture is allowed to stand until cold and then 50 parts of cold water are added slowly with regular stirring. Since Cellofas WLD is soluble in cold water at temperatures below 85° F this solution must be well cooled. A uniform viscous 5% solution is thus obtained which may be diluted to any desired concentration. Solution of Cellofas WLD must be used cold and should not be heated above 105° F.

Cellofas WLD may also be used very satisfactorily in finishing.

Cellofas TFW.

This is a product which possesses similar properties to Cellofas WLD but has the advantage that it is soluble in hot as well as cold water.

Tinting of Size.

In medium and heavy mixings a little blue dye is very often added to the mixing to take away the bad colour produced by the wheat flour. The quantity of blud added will depend entirely upon the quantity of size being prepared end its consistency. It requires

a comparatively small amount of blue to give a good colour to the cloth and care should be exercised that this is not added in too large a quantity. It is of course essential that the blue used should be soluble in water and fast to light. Care should be taken when selecting a blue that it possesses a reddish tint. The red has the power of neutralising the natural yellow tint of the cotton and produces a white effect. Whereas blue with a greenish shade should be avoided. Methylene blue and violet are employed for the purpose of giving a blue tint to the yarn. Dyes that have a deep ultramarine tint are also used.

Blue for Size Mixing.

A.	Malachite green crystal 229 B	1 dwt.
	Pure soluble blue crystal GMBH	3 ,,
	Pure soluble violet crystals	2 ,,
	For a size mixing of about 1600 pounds =	6 ,,

B. Oxamine blue BB
use as required

C. Formy violet
use as required

D. Indenthrene RSGM
use as required

E. Fast blue to light, acid or alkali,
1 oz. Indenthrene blue RZ
$\frac{1}{8}$ oz. ,, ,, RRNP

F. Alizarine Saphrol B.
This is very fast to light and it gives very white effect if used in size mixing.

G. Methol Violet B.B.

H. Tethasynol S.F.

I. Diamine Blue R.W.

J. For a mixing of 1400 lbs. (if the adhesive ingredient is chiefly composed of wheat flour) for a slight bleaching effect add 7 lbs of Rongalite c.
If still more whiteness is required then add 14 lbs. of Rongalite c. If still further whiteness is required then add 28 lbs. of Rongalite c.

Prepare your size mixture as usual and let it cool down to 160°F. Then add to it the above stated quantities of Rongalite C lumps which should be powdered. Stir well, after 10 minutes time the Rongalite c will be completely dissolved. Mix thoroughly and start sizing as usual.

K. Methaline Blue 3R.

L. Ultramarine Blue is a suitable shade for Bleached Warps.

For tinting to imitate cotton dyed.

2 lbs. Direct Black.
2 ,, Chicago Blue or Brilliant Blue.
Use as required.

Tinting is carried out also with the object of dyeing the yarns some distinctive colour, such as various shades of blue, (for coloured blanket) green, pink, heliotrope, which are dyed during sizing.

How to Test Blue.

In order to test blue for exposure to light, the following experiment may be carried out.

Weigh out two exactly equal portions of the blue, and dissolve one of these portions in a known quantity of water. This solution should not be of a very deep shade, but should be weak enough to be seen through. Allow this to stand in a glass for a few days then dissolve the other weighed portion of blue in exactly the same quantity of water, and when thoroughly dissolved compare the two. By carrying out this single experiment on several different blues at the same time, a good reliable blue may be selected.

In some cases it is required to tint American yarn forming a cloth so that it resembles one composed of Egyptian yarn. For this purpose a dye is incorporated in the size mixing so that the yarn will be tinted at the same time as the sizing process goes on.

The colours are :—

(*a*) Bismark brown ;
(*b*) Auramine yellow and chrysodium orange ;
(*c*) Chloramine yellow and benzo chrome brown G.
(*d*) Mikado orange.
(*e*) Chrysophene yellow.
(*f*) Chrysamine yellow.

Mixtures of auramine yellow and chrysoidine orange yield any shade of cream which may be desired. These two colours when mixed in suitable proportions produce a shade which is a very good imitation of Egyptian cotton. Methylene blue and methyl violet are largely employed for the purpose of reducing the yellowish shade natural to cotton. Basic colours fade much more rapidly under the action of light than the direct cotton colours. Instead of acetic acid and water, methylated spirit is some times used for dissolving basic colours.

Basic colour	= 2 ozs.
Acetic Acid	= 2½ ozs.
Water	= 1 Gallon.

Direct colours should be dissolved by boiling with water and a little soda ash in a suitable vessel.

Direct colour	= 4 ozs.
Soda ash	= 4 ozs.
Water	= 1 Gallon.

The solution of colours used for tinting the size should be strained through a fine cloth previous to being mixed with the size.

FARINA.

Farina or potato starch which is trade name for potato starch is obtained by pulversing raw potatoes and washing the pulp to remove the cellular tissue from the pure starch granules, which having a R.D. (relative density) of 1.5 are precipatated by gravitation.

The potato in its natural condition consists of about 74 per cent of water, 20 of starch, 2.17 nitrogenous substances, 1.65 cellulose 1.07 gum and sugar, .10 fat or oily matter, and 1.01 ash.

Farina is characterized by its glistening appearance, its crisp feel, its large starch granules, and the thick starch paste it forms with water when boiled.

Farina swells and thickens into a gelatinous paste more quickly in about five minutes and at a lower temperature than any other starch of commerce and grow thinner and thinner the longer the boiling is continued.

The writer is of opinion as the result of experience that less weight of farina is necesary than with sago as a beam will weave with two or three per cent less size on when farina has been used.

In a pure state it is less liable than others to mildew.

It also produces a relatively thicker paste than that of other varieties of starch, excepting Maize; but it possesses less adhesive and strengthening propeties, but it will hold about one-and-a-half times its own weight of china clay without dusting when the cloth is handled.

If used alone, Farina imparts smoothness to the yarn, which also retains its pliability, but it is only used in an uncombined state for sizing fine counts of yarn with a pure and very light size. For this purpose it may be boiled to a thinner paste by the addition of chloride of magnesium to increase its penetrating power.

It is advisable to use a mixture of Sago and Farina for all heavily picked goods in order to reduce the tendency of loss in strength as is the case if farina is used by itself.

When applied to cloth it gives a thick mellow feel. This feel becomes softer on ageing, and, for this reason, Farina is more suitable for certain finishes when a full, soft and clothing feel is required.

But in any case it is expedient to use Farina size paste immediately after preparation, otherwise 'soft beams' may follow as it soon loses its adhesiveness and 'falls away.'

But if farina is prepared in the right way it will not lose its sized value.

Farina should be heated only just sufficiently to gelatinize some of the starch and the boiling completed in the sow-box.

It becomes thinner and weaker by continued boiling, and also separates and liquefies if allowed to remain in a cold state. This, however, may be prevented by mixing the starch in water containing caustic soda solution, which not only makes the yarn more soluble and increases the adhesiveness of the size, but imparts to the yarn a smoother, softer, and mellower tone and feel. It also negatives the tendency to develop mildew.

In the summer months it has been found necessary to add a greater percentage of caustic soda. particularly if the size has to stand over the week-end, as there is a possibility for acid to be developed, and unless an extra quantity of alkali be added, the acid may be sufficient to entirely neutralise the caustic soda present.

It is very imperative to bear in mind that caustic alkali and chlorides of any description should never be employed in conjunction with each other as alkalies and chlorides are antagonistic or repelent bodies, and will not work together, and as the chlorides are indispensable the alkalies whether in the form of soda or soap must be kept out.

For Light, Medium and Heavy sizing Farina is usually blended with some other variety of flour or starch, or other binding material possessing stronger adhesive power, as wheat flour, sago and Maize starch, in which case it tends to make the yarn feel crisp.

Up to 60° or 65° C. or 140° or 149° Fah the starch granules remain unaltered in shape, but above this they begin to swell. On further increasing in size they begin to absorb water, untimately bursting, and taking up a peculiar star-shaped formation.

When between the temperatures of 60° and 85°C. or 140° and 185° Fah. gelatinization takes place. By this method it has been found that the bottom layers (those nearest the steam pipe) gelatinize far sooner than the upper layers, so that an enormous number of granules remain unaffected. Moreover the rapid formation of the jelly substance at the bottom prevents the upper portion of the starch from receiving an equal measure of heat. Therefore, in the centre of the hole will be found a certain amount of starch which has not gelatinized, and for the purposes of sizing this is purely waste.

A much better method of preparation is to make up a cold emulsion by mixing the dry starch with cold water either in buckets or in a separate pan or beck. It is not advisable to mix this in the beck in which it is required to prepare the starch (finishing beck).

Take the necessary volume of water in the finishing beck, and raise the temperature to 100°C. or 212° Fah. that is, boiling point. Then allow the cold starch emulsion to run in, keeping the dashers of the beck in motion all the time, and continuing to boil the water. The temperature, by this means, will not be lowered below the point of gelatinization 60° to 85°C. or 140° to 185° Fah., so that the outer skins of the starch granules will break up immediately causing complete gelatinization.

It has been found that in addition to this being a more economical and a speedy method, a much softer feel can be obtained on the cloth than is the case when starch is boiled up from the cold. 'If prepared starch paste is allowed to cool in the air, a peculiar change takes place. The length of time for this to be brought about varies

from minutes to days, a layer of perfectly clear liquid separates out on the top of the paste, the layer becomeing deeper as time goes on. This is due to the starch separating from the water, which is termed as falling away.

When the change takes place, the whole of the paste is useless, and has to be thrown away—this constituting one of the greatest sources of waste in the cotton trade.

Farina prepared by mixing the cold emulsion with boiling water will not fall away so speedily as that prepared direct in the finishing beck. The causes of falling away are (*a*) the tendency for solids to separate from liquids, (*b*) the presence of acid in the tallow or other substance used in a mixing. The effect in the latter case is due to the acid's action on the bacteria in the starch, caustic soda being applied to counteract this.

How to select Farina.

In selecting farina take the one with the least percentage of water. The same test for moisture may be made as in the case of wheat flour, also apply the test for strength of paste as for flour. It would be well, however, to carry this further, allowing the two mixings to stand, and noting which liquefies or falls away first. The tests for mineral matter may also be employed as in flour. A good pure farina would contain practically no ash or so much as to be almost unweighable if 20 grams or so completely ignited.

Colour.—Farina intended for sizing purposes should be of good colour. Dark samples will impart their shade to the cloth, and where whiteness is required, such a sample would be objectionable.

Farina should always be examined under the Microscope. The granules will be found to be larger than those of wheaten starch, oval in shape, and marked with eccentric rings. The more uniform the granules the better the quality as a rule. Very large granules are not desirable, and a large number of very small ones indicates that the potatoes from which it was manufactured have not matured.

Maize Flour and Starch.

Maize flour is produced from Indian corn grains, and the starch obtained either by fermentation, or chemical treatment. Maize starch produces a relatively thicker paste than that of other varieties of starch, and, like rice starch, it requires to be well boiled to effect a thorough bursting of the hard and tough granules, which otherwise tend to impart to yarn a harsh, brittle, and wiry feel. For these

reasons maize starch is rarely used alone, excepting for pure and light sizing, and is therefore usually blended with wheat flour or other binding agent to reduce the harshness of the granules, and thereby impart to the yarn a softer and mellower tone.

The importance of effecting a thorough disintegration of the clusters of maize starch granules, either by prolonged boiling or by treatment with chloride of zinc, caustic alkali, is emphasised because of the greater tendency of maize than of other varieties of starch to develop under similar atmospheric conditions, mildew and other forms of decomposition.

For light and pure sizing, Maize starch and Wheat flour may be boiled separately and afterwards combined; or they may be steeped, fermented, and boiled together. But for medium and heavy sizing china clay, chlorides of zinc and magnesium may be combined with the starch to be all boiled together in the boiling pan, and afterwards mixed and boiled with the fermented wheat flour ready for use.

On account of dusting nature of Maize starch it should be used with flour in proportion of $\frac{1}{3}$ Maize starch to $\frac{2}{3}$ of wheat flour.

Instead of using chlorides of zinc and magnesium, a superior size mixing is obtained by steeping the starch in caustic soda solution of 50°Tw. (R.D. 1.25) in the proportions approximately of 0.3 Gal. (3.75 lbs.) caustic solution to 100 lbs. starch.

The action of the caustic alkalies effects a more complete dissolution of the starch granules, which become more soluble, and therefore produce a paste of more homogenous character, uniform consistency, stronger adhesive power, and also one that imparts to the yarn a smoother, softer, and mellower tone and feel. Furthermore starch treated in this manner is much less liable to develop mildew.

The sizing power of corn starch acts more uniformly on warps than either potato starch, wheat starch, or any other starch. The size itself remains constant and dependable. The strength being uniform standing overnight or from Saturday until starting time Monday and can be reboiled without affecting the sizing value. Maize starch is not fermentable, but like other organic substances is subject to decay, although in a lesser degree than many other organic matters. It becomes musty when stored in damp, poorly ventilated warehouses. It is very hygroscopic and easily and quickly absorbs moisture from the atmosphere. Starch stored in a damp place has

been known to absorb 30% moisture. This mustiness is easily remedied by drying with a gentle heat or allowing dry air access to the starch.

All starch decays easily and quickly after being made into a paste or size solution in hot weather, unless some preventative, such as, formaldehyde or benzoate of soda or caustic soda or any good antiseptic is used to prevent it.

A mixture consisting of equal parts of maize starch and farina forms a very good starch 'filling' which gives a feel to cloth similar to that produced by wheaten starch.

Maize or corn starch be carefully scrutinized under the microscope, and a sample showing small and regular rounded granules will be found. Each granule has a characteristic star—shaped appearance in the centre. They are smaller than the larger wheaten granules when viewed under the same power.

Maize starch usually contains about 13 to 14 per cent. of moisture, and less than one per cent. of ash.

Many proprietary brands of starchy materials contain maize starch as one of the ingredients.

Maize Flour.

Maize flour is used only occassionally for sizing purposes. Because it is not easily gelatinised by boiling.

Soluble Starch.

Soluble Starch, under various fancy names, has been put on the market. It is manufactured principally from maize starch or farina, or from mixtures of the two starches. Soluble starch cannot be used to the same extent in Sizing as in Finishing Cotton cloth. Because the processes by which starch is rendered soluble destroy its adhesive powers to a very great extent, and hence this renders it useless for the purpose of fixing mineral substances to the yarn, and at the same time reduces its strength-giving powers extensively. This latter condition is a matter of little importance in Finishing but it is a matter of great consequence in the process of sizing particularly, in the case of Medium size. But it may be used with advantage in very heavy sizing for the purpose of tinning down the mixing. This is probably due to the fact that commercial soluble starch generally contains a trace of free acid. This will act upon the

other starch of the mixing, and cause it to boil thinner than would otherwise be the case. The adventage to be gained, is, that in thinning down a very thick size it can then be easily handled.

Composition of Soluble Starch.

Starch	= 79.25%
Mineral Matter	=0.67 ,,
Water	=20.08 ,,
	100.00 ,,

Percentage of Starches.

Wheat Flour	= 65.21%
Rye	= 61.26 ,,
Oats	= 37.93 ,,
Barley	= 64.63 ,,
Buck Wheat	= 43.80 ,,
Maize	= 65.88 ,,
Rice	= 85.78 ,,
Potatoes	= 20.00 ,,

Penetrose.

This product is manufactured in three grades of fluidity which means the thinness of the paste formed when boiled with water.

The order of the fluidity is as follows :—

No. 1.—Fluidity 75, suitable for high grade warps.

No. 2.—Fluidity 40, suitable for pure Sizing.

No. 3.—Fluidity 20, suitable for Medium and Heavy Sizing.

Tin Boiling Starch.

Thin boiling starches are insoluble in cold water, and, therefore, they are not mixtures of dextrine and glucose. They gelatinize when boiled and 'jell' on cooling.

When speaking of starch pastes the term viscosity and fluidity are both used. A high viscosity means a low fluidity, and *vice versa*. Thin boiling maize starch should be boiled at least forty-five minutes to completely gelatinize the starch granules, and that the final consistency should be adjusted to the class of work in hand. It can be boiled longer than the above specified time if so desired without

any fear of its thinning down any further. Provided it is protected from further dilution by condensed steam, it will remain, for all practical purposes, constant until consumed. This is brought about by maintaining the temperature of the boiled size in the mixing beck or pan by means of a closed steam coil instead of using live steam. Thin boiling starches are chiefly used in pure or light size. In size greater than 25% where china clay is used, it is seldom used and perhaps if used only in conjunction with wheat flour.

Tapioca Starch.

Cassava is a 'root' starch produced largely in South America. It is prepared as a good starch under the name of Tapioca. It is seldom that the cotton manufacturer buys it in the pure form, although he certainly gets it in certain sizing starches that are sold under special trade names.

Tapioca, on pressing it between the finger and thumb, feels harsh, crisp, gritty like rice starch. Tapioca starch, however, is inferior to other varieties of starch for sizing yarn, because it yields a paste of feeble adhesive properties, and its variable quality makes it very unreliable.

Size paste prepared from tapioca also loses its tenacity, and liquefies by continued boiling or if left in a cold state, in the same manner as that prepared from farina.

Cassava under the microscope appears in somewhat hemispherical granules which have a central hilum, in appearance a dot or short slit.

If Tapioca is mixed with Pearl Sago or Sago flour, it is capable of giving as good results as some of the weaker brands of Farina if a small addition of caustic soda is made. At times when the price of Farina is much higher than Tapioca then Tapioca is passed as in place of Farina. Tapoica is also used for adulterating Sago and Farina. White dextrine produced from Tapioca can be used for light finishing.

Rice Starch.

This starch is produced in precisely the same manner as maize starch. While rice starch is not often used in sizing cotton yarns, yet it is very extensively employed for laundry work as it has fine stiffening property.

The granules are small, harsh, and when dried, produce a very rough yarn and a cloth of 'boardy feel'.

Many sizing flours contain small proportions of rice flour or rice starch, these admixtures enabling the user to obtain various cloth effects, particularly in regard to feel.

Rice Flour,

This substance is produced by grinding the seeds of the rice plant. It is sometimes mixed with wheaten flour in sizing, to give a crisp, hard feel to the cloth. The proportion of the mixture is six to ten parts of wheaten flour to one part of rice flour. It is best to steep the rice flour with the wheaten flour or preferably boiled alone or with the China clay, before adding to the flour. It may sometimes be found in wheaten flour, as an adulterant. Its presence can be detected under microscope. The granules of this starch are amongst the smallest known, their polygonal shape rendering them easy of detection. When rice flour, or ground rice, is under examination, it is necessary to grind it in water for some little time, in order to bring about a separation of the starch from the gluten, and so render it fit for examination.

Sago Flour,

Sago is a starch, generally miscalled flour amongst merchants and sizers owing to its being sold under that name.

It was first used—according to a patent specification—in 1860. In spite of its somewhat yellow natural appearance it is greatly esteemed as a sizing starch, because it immensely strengthens the yarn and allows it to stand a 'high pick.'

It is usually a nearly pure starch, but the ash is higher than that of farina, and is sometimes of a gritty nature.

It is chiefly employed for sizing yarn of fine counts with a light and pure size which imparts great strength to the yarn and leaves it pliable. Sago starch paste is greatly improved by prolonged boiling which affects a more thorough dissolution of the starch granules. The boiling should be more prolonged than with farina.

But bear in mind that it has a little tendency to liquify on prolonged boiling.

A superior mixing for light and pure sizing of great adhesiveness is obtained by first mixing the starch in water containing caustic soda Solution of 50° Tw. in the proportions of 1.25 to 1.75 lbs. caustic solution to 100 lbs. starch, and also by adding about 30 to 25% of farina to the weight of sago flour which has been previously well boiled. Sago, if used in large quantities, dries very 'harsh' and cut the healds in weaving. Therefore it is wise to steep the sago overnight in cold water and boil up in the morning. Sago has an advantage over farina in that it does not fall away so easily.

It presents a very typical appearance under the microscope. The ends of the granules are distinctly truncated that is, it has a characteristic egg-shaped appearance, each granule seeming as if the end had been clean cut off. Low grade sago flour is liable to be contaiminated with sea water. It is therefore necessary to test samples for the presence of chlorides. Where wheat and Sago flours are both used in the mixing, it would probably be a further improvement if both varieties were put down together and steeped with the zinc chloride solution .

Dextrine $C_6 H_{10} O_5$. or British Gum.

It is little used in sizing on account of its sticky nature, but it can be used with satisfaction if mixed with farina or sago for the purpose of giving a full "feel" to the yarn in pure sizing. Dextrine is merely one of the intermediate products in the conversion of starch into sugar. The white dextrines contain soluble starch, and the brown varieties contain more or less glucose.

Apparatine and Gloy.

These are examples of ready-made sizing and finishing starch pastes prepared from soluble starch and sold under a variety of trade names. These, or similar preparations, may be produced by first mixing 100 lbs. (76%) farina or other variety of starch with 50 galls. =500 lbs. (80%) water, and afterwards adding slowly 2 galls. caustic soda solution at 50° Tw. (R.D. 1.25) which at that density is equal to 25 lbs. (4%). There should be employed for this purpose a wooden mixing beck containing dashers, and without nuts, bolts, or other metal fittings being exposed inside the beck. Whilst adding the caustic solution, the dashers should be put into action, and continue to revolve until the mixture becomes a translucent gelatinous paste of the required consistency, when sufficient acid to neutralise the alkali and arrest its further activity in dissolving the starch, should be added; also, if required, the paste may be made of

firmer consistency by heating. Starch paste thus prepared is practically immune from the usual consequences of bacterial infection which conduces to a state of decomposition and mildew, even if exposed to the atmosphere.

Gum Tragacanth, Gum Arabic & Gum Senagal.

These constitute the three principal varieties that are sometimes, employed in combination with other ingredients for the purpose of sizing yarn, but more frequently for finishing cloth, as the two last-named varieties tend to impart to yarn a harsh and stiff feel.

Gum Tragacanth.

The colours vary from light-brown to dark-brown, but the lighter it is the better its quality. There is only about 9% of actual soluble gum in gum tragacanth, but by reason of its binding property it is sometimes used in size mixings, although the advantage is exceedingly slight, and it is an expensive substance.

The mode of preparation is to macerate the gum in cold water for about 24 hours during which time it swells considerably, though it does not dissolve until it is afterwards boiled for several hours; or dissolution of the macerated gum may be accelerated by boiling it for a period of only 15 to 20 minutes under a pressure of 60 to 70 lbs. in a boiler or kier. In a cold state the mucilage of gum tragacanth gives a violent reaction with iodine solution; hence it is surmised that it contains a certain amount of starch substance.

Gum Tragasol.

This gum is produced from the kernels of the locust beam. It forms a strong adhesive and is used in light sizing. Combined with starch and china clay, it is suitable for heavy sizing also, imparting to the yarn a smooth feel. When this gum is used in a mixing, a portion of the tallow can be dispensed with. Another good feature is that the gum is practically immune from mildew.

Gum.

Natural gum exudes in the form of a juice or sap from certain shrubs and tress which yield gum of different varieties according to their species.

Gum Arabic (C_{13} H_{22} O_{11})

Gum arabic is a natural exudation from the Cacia plant. The several forms as commercial gums are completely soluble in one—and—a—half times its weight of water, to form a strong mucilaginous colloidal liquid adhesive and binder, in a thick viscous solution. The presence of any insoluble part is an indication of an impurity. The addition of a small amount of common alum to the solution will increase its adhesive properties. The commercial product comes in powdered or in irregular granular form, in colour from a pale yellow to a brown. The commercial product that comes in powdered form is adulterated either with French chalk or China Clay. It is odourless, with a sweet taste. It is known in the pure state as gum acacia. As starching for cotton piece goods, it lends its characteristics in stiffening fine goods, and it does not discolour the starch batch, however white this may be. It is used in the Folding Department for pasting tickets on finished goods, the selection being due to its nonstaining qualities. It does not deteriorate or sour on standing, but dries out into its original form and structure on the loss of water.

Gelatin and Glue.

When soaked in cold water for 24 hours, should give a firm sweet smelling jelly, leaving a colourless liquid. Sulphurous acid is frequently present in considerable quantities.

Sea-Weed Mucilage.

It is sometimes employed in cloth finishing, but rarely as a sizing ingredient because the presence of salt tends to impart to the yarn a harsh feel. This tendency, however, may be reduced by steeping the weed or moss in cold water previous to macerating it in either hot water or an alkaline solution. After boiling the substance is strained to separate the 'pectin' mucilage from the cellulose tissue, and the jelly thus obtained may then be combined with other sizing ingredients as required.

SOFTENERS.

Tallow.

It will be found that for the first time in 1841 a public reference is made to the use of lard, tallow, oil, wax, and spermaceti, though undoubtedly most of these substances had been important sizing ingredients long before. No way has been discovered yet of despensing with adhesives as sizing ingredients, nor has it been found possible

to use an adhesive only, as the redried paste is much too harsh for efficient modern production. There is no question but that the most successful results in these branches are obtained by using mixings that contain three sizing ingredients only namely.

Pure starches; some good tallow; and a little high-grade soap.

Fats play an important part in the composition of sizing and finishing recipes when used in their natural state, because of their want of affinity with water and difficulty in getting a homogeneous mixing and their Specefic gravity, they always tend to rise to the surface of the mixing, resulting in enormous variations during theip use. Hence it is preferable to use them in saponified and emulsified form.

If some ingredients with a more or less greasy nature are not mixed with all flours and particularly if combined with weighting substances it would not only make the yarn hard and harsh, when dried after application would brush or crumble off into dust and also the warp would break frequently in the loom. If the yarn is made harsh and not pliable by the size, then this characteristic enters into cloth, and if the size brushes off by friction on the threads, it is obvious that the process is a useless one. In order, therefore, to avoid these results, materials termed softeners are introduced into the mixing, being of an aleaginous character to preserve the soft and supple qualities of yarn.

There is no substance as yet placed upon the market which will give as good results as tallow for any class of sizing where magnesium chloride or zinc chloride is the constitutent of the size mixing. It is nearly impossible to obtain same softening effects by substituting soap or any other tallow substitutes. Tallow also ensures lubrication and prevents sticking to the cylinder's surface.

Characteristic properties of good tallow

Tallow is an animal fat obtained from rendering of salt, its composition being solid fat and oil. Tallow is imported from Russia, Australia, and England. Russian tallow is considered the best as the animals are kept on dry fodder for eight months of the year. This tends to make a harder and a firmer fat. If tallow is thin it does not readily incorporate with the size, but floats on the top. It should be of a firm texture. The colour should be white and free from offensive smell. It should not change colour or turn rancid on exposure to the air. It should possess a high melting point of about

110° to 120° Fah. (43° to 50° C.) for beef tallow, and about 116° Fah. (47° C.) for mutton tallow, and free from gritty matter. But it must be observed that as the material becomes older, the melting point of beef tallow falls to about 104° Fah. (40° C.), whereas that of mutton tallow rises. It is sometimes found to contain too much water which destroys its softening properties, and to know how much it contains one has only to liquefy it, when oil and water will be distinctly separated. An easy way to determine its quantities in its original state is simply to expose it to the atmosphere for a certain time, and if it in the mean while gets darkened or begins to give out a rancid smell, the test is conclusive, and it should be rejected as useless. The rancid smell sometimes given off by tallow is due to the presence of either sulphuric or hydrochloric acid which is left when tallow is not thoroughly washed after bleaching. Acids can do a vast amount of damage to the cloth. It only requires a very small amount to produce iron stains due to the effect of the acid upon the metal parts of the loom. Fatty acids, which have their origin in rancid tallow, are liable to cause damage to the copper rollers of the tape frame.

Vaporising point

Pure tallow in the winter months, vaporises at from 260° F., to 320° F., according to the quality of the fat, the higher the vaporising point, the better the tallow. In the summer months the vaporising point is considerably lowered. But it should never vaporise below 240° F. A tallow having a high melting point is rarely an adulterated one.

Test for presence of free acid

Take a small portion of tallow and about three times its weight of water and heat the whole till the tallow melts. On cooling, a layer of pure fat covers the water underneath, which, when poured in few drops on litmus paper, produces a red colour indicating the presence of free acid. The acid is sulphuric, if on addition to the water of a drop of hydrochloric acid and two or three drops of barium chlorides a white precipitate be the result, and it is hydrochloric, if a similar precipitate obtains on adding to the water a drop of nitric acid and a few drops of nitrate of silver.

Another method of testing is: Place a small portion of the tallow in a test tube and cover it with a very dilute solution of methyl orange. If no change takes place, warm the liquid. Should this

change to a pink tint, the indication is that mineral acid is present in the tallow. The mineral acid in tallow has the effect of tendering the yarn. There are several varieties of softeners in use, some being entirely animal, some vegetable and some chemical.

Fats should be neutral when the solution, e.g., if some tallow be dissolved in ether, divided into two portions and a piece of lithmus paper be placed in each, one blue and the other red, there should be no alteration in either.

The use of too much tallow induces mildew

Animal softening substances are in general use—they are the best. The use of tallow in sizing should for obvious reasons be as much restricted as possible, perhaps not only for the sake of economy as a slight tendency it has to induce mildew. This property is due to the partial decomposition it undergoes when boiled with the other constituents of the size. Fats are not, as was formerly supposed, simple organic bodies, such as sugar, alcohol, or ether but true chemical combinations of acid and base, both being of an organic nature. Animal fats, butter, and some oils are composed of three compounds namely stearine, margarine, and obine, and these again are constituted respectively of stearic, margaric, and obic acids, united to a base to which the name of glycerine has been given.

Mildew is a plant, and a phosphate is essential to its growth; therefore the presence of a phosphate in a cloth means almost certain damage by mildew.

Tests for adulterants in tallow

Tallow should not be judged entirely by its colour, for this does not always indicate its class. Moreover, a good white colour can easily be obtained by adding starch and china clay; this can easily be detected by what is known as the chloroform (methylated) test. Treat the tallow with the chloroform, and if there is any residue at the top of the liquid, it is starch. If there is a deposit at the bottom, it is clay. Whiting is also put into tallow to give a good colour. As a test, dissolve a little of the tallow in petroleum spirit, and then add a few drops of hydrochloric acid. If whiting is present the liquid will effervesce. A drop of methyl-orange will often indicate the presence of the mineral acid which is used to bleach it.

Presence of paraffin oil on wax

Boil two or three drops of tallow with alcoholic potash solution for several minutes and then add an equal quantity of warm water. A white turbidity to precipitate indicates the presence of paraffin oil or paraffin wax, or similar adulteration. Burn a weighed quantity in a crucible and find the percentage of ash present. From pure tallow it is almost nil.

Test for bone fat in tallow

This test should always be carried out in connection with tallow. Mix a portion of the tallow with water and hydrochloric acid and then raise to a boil, keeping it well stirred. Now allow it to cool, and pour off the liquid extract obtained, the hydrochloric acid having dissolved out the calcium phosphate (phospate of lime) from the bone fat, if such were present. Then put some ammonium molybdate into a test tube, or boiling tube, and add a little nitric acid. Warm this over a Bunsen-flame, and then add two or three drops of the liquid extract just obtained. If calcium phosphate is present indicating bone fat in the tallow, the contents of the tube will assume a canary-yellow colour, and upon being warmed will yield a precipitate. Bone fat is sometimes specially treated for sizing purposes with a view to the removal of the calcium phosphate. This would be quite suitable for sizing.

Test for chlorides

The presence of the various chlorides may be determined by testing a portion of the liquid with nitrate of silver and nitric acid. In the absence of calcium and magnesium, the production of a large amount of the curdy white precipitate of Chloride of silver would indicate the presence of common salt.

When it is desired to take a sample of tallow the best method to adopt is to force a long brass tube right down to the bottom of a full barrel, then give the tube a sharp twist to loosen it and draw out. The tallow is forced out of the tube by a plunger which fits into it. By this means the contents of the whole barrel can be examined, and any attempt to deliver tallow in various grades, the worst being at the bottom and normally out of sight, is frustrated when sending samples out for testing purpose. It should never be sent out in paper wrapper, but in a glass bottle; and heat up to tallow melting point, then allow the sample to cool, keeping the bottle tightly corked

Tallow Substitutes or Patent Softeners.

Many of these substances are on the market, and are made up of various ingredients. In practically every instance the greater part is composed of about 60 to 70% of water, and in many cases no fatty substance is present. One of the best tallow substitutes is composed of tallow, caustic soda, glycerine and water, others being of the same construction with the addition of starch. Many so-called tallow substitutes are merely soaps, and as such, are useless for heavy sizing where chlorides are used.

For light sizing, by far the cheaper and better method would be to make up soap solutions by mixing white windsor or soft soap with water, adding a small quantity of glycerine to assist the weaving.

Waxol T.

Recent advances in softening and lubricating agents for sizing have been directed largely at replacing raw tallow by products which are more easily dispersed in the size mixture and which show no tendency to grease separation on standing. Waxol T is such a product. Waxol T is first mixed with a little warm water and then added to the preboiled size mixture. A short stirring gives completely uniform distribution of the softening agent throughout the mixture in a stable form. The uniform and fine distribution of Waxol T ensures level application to the fibre.

Waxol T possesses excellent softening properties and in addition to its use in sizing may be used also as a genera softening agent.

Tallow substitute from vegetable oils

A mixture containing say

80% groundnut oil
15% coconut oil
5% castor oil

100%

with an iodine value of 72.1 and saponification value of 194.9 will give on hydrogenation a product which has approximately the same chemical and physical constants as mutton tallow. It can safely be used and it will produce under identical condition equally good results in the process and on the finished goods.

FATTY SUBSTANCE.

Description.	Solidifying of Fatty Acids. °C	Melting Point of Fat °C	Free Fatty Acids.
Beef tallow	38.5/46.2°	43/48.5°	0.5/25
Mutton tallow	40/48°	44/49°	1.75/15.2
Russian P. Y. C. (fresh) ..	....	....	2.2/2.35
,, ,, (old) ..	....	....	2.55/12.3
Bone fat	28/45°	21/22°	18/29°
Cocoanut oil	19/23°	23.5/25°	4.2/10.06°
Castor oil	3°	....	.14/1.06°
Olive oil	21/24°	....	.2/.5°
Cotton seed oil	32/38°	....	....

ANALYSIS OF MUTTON TALLOW.

Melting point	= 44°C.
Specific gravity at 100	= 0.867
Vapour point	= 394°F.
Open flash point	= 592°F.
Burning point	= 654°F.
Saponification value	200
Iodine value	39.2
Acid value	= 0.56
Ash	Nil
Colour	White
Consistency	Normal
Smell	Good

The use of Soap in Size Mixing

For some considerable time it has been held as an opinion that the real function of soap as a softening agent is its ability to effect a more complete emulsification of the fat, which recent experimental research work has confirmed. Consequently the softening effect of a certain amount of tallow in the presence of a small amount of soap becomes more evident than that of a much larger amount of fat in the absence of an emulsifying agent. But bear in mind that, for Medium, Heavy or very heavy sizing it is usually impossible to admit soap as an ingredient, because for weighting purposes it has become a very general practice to add other ingredients besides China clay, which react with it. It is the presence of metallic-chlorides like those of Zinc, Calcuim, and Magnesium, and the sulpha-

tes of magnesium and calcuim, which react with soap to produce mettalic compounds of objectionable character, that is responsible or this prohibition.

But where a size mixing contains starches, gums, dextrine, etc. together with tallow, fats, or waxes, and say china clay only, soap may be added giving similar results to those obtained in light sizing.

Wax

Wax of many varieties is sometimes employed either in conjunction or in combination with tallow, oil, etc., as an emollient for size mixing. Its use should be confined strictly to sizing warps for such fabrics as are to be sold in a grey state, that is, not bleached, dyed, or printed. There are three classes of wax obtainable, namely 'Bees', 'Japan', and 'Paraffin,' also spermaceti wax and wool grease.

Bees wax

Bees wax is not used in sizing owing to its scarcity and cost, although several compositions are sold under the name. In the commercial form it is a hard solid substance of a tone varying from dark brown to white, according to degree of refinement. It is also frequently adulterated with paraffin and other cheaper and inferior wax products that tend to reduce the melting point of bee's wax, which should not be lower than about 144° Fah. (62°C.)

Japan wax

It is often wrongly called bee's wax. It is a soft fat consisting of palmitin or oil, obtained by pressure from an indigenous Japanese tree, with a high melting point about 122° to 129° Fah. (50 to 54 C) and especially useful as a softening agent. In combination with castor oil its value is increased, and probably no other softeners can yield an effect so satisfactory. The use of this wax, however, is not very general owing to its comparatively high price. It consists of hard solid substance having a light yellow tinge, and a rough crystalline structure that glistens like broken fragments of alabaster.

It saponifies under the influence of caustic alkali and other powerful bleaching agents. It also emulsifies more readily than other varieties of wax, excepting spermaceti, and combines with other sizing ingredients more freely than other wax during size mixing.

The use of Japan and spermaceti wax as emollients for sizing, therefore, is not so objectionable as bee's, Chinese carauba, and paraffin wax, as the two former kinds are much less difficult than the latter to remove from the yarn by the process of bleaching.

Japan wax whether used alone or mixed with spermaceti is an excellent sizing ingredient for yarns which are liable to receive much rubbing on the loom. Japan wax produces high bluestre in conjunction with borax if used in a damping mixing.

Paraffin wax

It is obtained in the manufacture of paraffin and petroleum oils. It is rèally the heavy oil when cooled and compressed into a solid body. In its crude condition it is of brownish colour but by several purifications it becomes whiter, drier, and heavier. The melting point varies from 100° to 140° Fah., according to the oil from which it is delivered. But that having a melting point of about 120° to 125° Fah. (49° to 52°C.) will meet the requirement of the sizing purposes.

This wax is restricted to the size applied to the yarn for unbleached heavy goods, such as, long cloth, *Dhoties*, sheetings, etc. It should not be introduced when the cloth is to be dyed, bleached or printed owing to its colour and a chemical action (that which is not easily dissolved by lime or soda) which renders the cotton incapable of taking a dye.

It does not emulsify readily, and is often found floating if used in a size mixing in a thick layer on the top of the size in the sow box. If it gets on to the yarn in the process of sizing, it does so in patches. If wax is to be used to get a certain feel it is best to do so by mixing Japan was and Spermaceti. Cloth sized with paraffin wax becomes yellow on keeping. Paraffin wax produces a high lustre in conjunction with borax if used in a damping mixing.

Spermaceti wax

It is a solid white crystalline fat reduced from oil obtained from the head cavities and blubber of the spermaceti whale, and it melts at a temperature ranging from about 115° to 122° F. (46° to 50°C.). Its high price, in comparison with that of other softening materials that are considered to be of equal and even superior merit, restricts its wider adoption as a sizing ingredient, although it has to some extent good virtues as an emollient. If mixed with Japan wax in the proportion of half and half, it gives good results.

Spermaceti is liable to be adulterated with hard tallows, animal waxes, and paraffin wax.

Waxol PA.

Waxol PA is a softening agent suitable for incorporation into size mixings in the place of paraffin wax. It may also be used to replace Japan wax. It represents a considerable advance over the use of raw paraffin wax because lt is very much more easily and more uniformly incorporated into size mixing thus resulting in more level and uniform application to the yarn.

In use $2\frac{1}{2}$—5 lbs. of Waxol PA per 100 lbs. weight of sizing mixture should be sufficient. The Waxol PA should be stirred with 3—4 times its weight of water at 105—120°F. and then added to the preboiled size mixture. A little stirring will produce absolutely uniform distribution of the Waxol PA.

Wool grease

This substance is excreted through the skin by sheep and collects in the wool by absorption. In wool washing it is extracted in a very impure condition. When highly purified a very valuable neutral wax is obtainable which is sold under the name of 'lanoline' and has been largely used in the preparation of ointments due to the very characteristic property it possesses of being readily absorbed by the skin. The crude 'recovered' or 'Yorkshire' grease is a mixture of free and combined fatty acids and alcohols. It is a dark yellow or brown viscous substance of melting point 39° C. to 42° C., specific gravity 0.973 at 15° C., and has a distinct smell of sheep.

Mineral oil

Mineral oil of any description should not, on any account, be employed, either alone or in combination with any other emollient for sizing purposes, since, like the mineral wax, paraffin resists the action of bleaching agents, does not saponify under their influence, and is difficult to remove. It is therefore liable to cause stains and other blemishes of a serious character in the finished cloth.

Palm oil

Palm oil, in a bleached and highly refined state, is used extensively as an emollient for size mixing and finishing both in pure state and in conjunction or in combination with other softening materials. It varies considerably in consistency. The melting point varies to the same extent as the consistency. Unbleached palm oil varies in colour from a brownish yellow to a deep orange and has a characteristic, but not unpleasant smell. The oil is frequently adulterated with water.

Olive oil

Various species of olives are cultivated for the sake of the oil contained in the pulp of the fruit, but the oils differ slightly from one another in their chemical and physical characteristics, though their qualities and flavour vary.

It is used extensively in the manufacture of soap and also for numerous domestic purposes, but its dark tone of colour makes its use objectionable for the purpose of sizing yarn. The grades of olive oil are of a golden colour and have an odour of the fruit. The second quality, also, known as 'table oil,' is not so bland in flavour or aroma, while the oil subsequently extracted goes by the name of 'ordinary' or 'common' oil, and has a greener colour and a sharper and bitter taste.

This oil is used in "finishing," but only to a limited extent. It is frequently adulterated, with cotton seed oil, mineral oil, and rape oil.

Castor oil (Ricinus communis)

This oil is one that is obtained from the castor oil plant. It is the only oil found useful for sizing purposes. Because the other oils such as cocoanut, palm etc., have been found not only having a low melting point about 75° F. and 90° F. respectively, but also they are subject to decomposition and their use should not therefore be encouraged to any great extent. Castor oil is used as a softener. It is a vegetable extract and usually possesses a pale colour, viscid consistence, and a slightly hawkish odour. It has a specific gravity of 957 at 77° F. Being in great demand it is often adulterated, and care should therefore be taken that it is free from outside matters and well purified.

Purified castor oil is of a pale straw colour and remains liquid when cooled far below the freezing point of water. It differs from most other oils in being very soluble in alcohol.

It should be tested by taking its specific gravity and noting the increase of temperature produced by mixing it with a little sulphuric acid. Adulteration is detected if temperature is more or less than that registered with the use of a pure sample. It is an oil of great body, and well adopted for intermixing with the other sizing ingredients, thus effectually preventing them from making the yarn harsh and wiry. It gives a whiter and better appearance to the cloth, and being colourless it is not very expensive.

Size mixing containing tallow and castor oil (or vegetable tallow prepared from it) gives a good result not only in the process of weaving but also in the after-weaving process, that is calendering. The castor oil must be boiled in the clay pan with water, ten to fifteen minutes, and then china clay must be mixed. It should not be excessively used.

Caster oil is extensively employed in the manufacture of the Turkey Red Oil required in the dyeing and printing of cotton goods. It is prepared by treating castor oil with sulphuric acid under suitable conditions.

It is largely used in dyeing and bleaching in the form of soluble oil.

Castor oil bleaches in the sun if kept exposed for a few days.

Cocoanut oil

Cocoanut oil has a melting point ranging from about 70° to 80°F. (21° to 27° C.) but because of its marked tendency to decompose rapidly, and darkening the colour of cloth, its use as an emollient for sizing is not advisable, and it is better avoided. But it may be used as a softener in finishing. Cocoanut oil combines with alkalies, producing soaps. It is used in a very small quantity in damping mixing as a help towards getting lustre in the cloth.

Cocoanut oil is used in Size mixing in conjunction with Epsom salts. It has the property of mixing more readily with this substance than any other oil or fat. Sometimes Turkey Red Oil is used instead of Cocoanut oil.

Cotton seed oil

Cotton seed oil is used as an adulterant of tallow and Wax. Because this oil has nearly the same proportions as olive oil it is substituted for it.

Glycerine ($C_3H_5OH_3$)

A colourless deliquescent liquid boiling at 290° C. should burn completely upon incineration, and leave no ashes.

The hydrochloric acid test will give a white precipitate if salt is present, and sample should be rejected.

Glycerine is an essential constituent of most varieties of oil and solid fat and it possesses certain properties common to those materials. It constitutes a very valuable sizing material being a powerful

emollient and softening substance which also possesses exceptionally deliquescent and antiseptic properties that have no injurious effect upon yarn or cloth such as chlorides have. Nor is it easily liable, as tallow, fat, and oil to decomposition. In fact, as an ingredient of pure and light sizing, with the sole object of improving the weaving qualities of the yarn, and not of increasing its weight by the addition of china clay or other weighting material, glycerine has no equal. A sizing preparation consisting of starch paste and glycerine embodies all the properties that are essential for pure sizing. In pure size it gives great suppleness, and, by its deliquescent properties, prevents any tendency of the adhesives to become harsh or brittle. The admixture of glycerine with the size effects a definite improvement in wear resisting power. The beneficial effect of glycerine may be due to one or both of two facts, (*a*) that glycerine acts as a hygroscopic agent, and renders the yarn more supple, and more resistant, and (*b*) that glycerine acts as a definite medium for gelatinisation of the starch.

The price of glycerine prohibits its more extensive use as a sizing ingredient.

The 'glycerine substitutes' that are placed on the market are often only solutions of glucose sugar, and are almost useless for sizing purposes. Glycerine mixes in all proportions with water and alcohol, but is insoluble in carbon disulphide and chloroform. Taste is a very good test to apply to glyderine—if impure, it is distinctly unpleasant. A good sample of commercial glycerine yielded the following results on analysis :—

Sp. gravity 1.3, 80 per cent to 82 per cent real glycerine, 10 percent ash, and gave no precipitate on being added to strong hydrochloric acid.

Pure glycerine of normal density has a R.D. of 1.28 (56° Tw.). It does not evaporate or dry up, but, on the contrary, is very deliquescent or hygroscopic, and if exposed to a moist atmosphere, it is capable of absorbing an amount of vapour equal to about 50% of its own weight. Even when exposed in a room, during a period of two weeks to a warm and relatively dry atmosphere, a given quantity of glycerine of 52° Tw. (R.D. 1.26) increased gradually to 8.5% more than its original nett weight, when its power of absorbing moisture, under those conditions, ceased. Being such a powerful deliquescent, and of greater potentiality as such than chloride of

magnesium, glycerine should not therefore be employed in an excessive amount for sizing yarn for cloth which is likely to be exposed to a damp climate, otherwise the yarn will become sticky and difficult to deal with.

Glycerine as a softening ingredient exhibits its softening properties in dry weather.

The testing of glycerine :—

(1) Find its specific gravity.

(2) Add some to an equal volume of strong hydrochloric acid in a test tube. Invert the tube two or three times to thoroughly mix the two liquids, and then allow the mixture to stand for half an hour. If at at the end of that time no white precipitate has been deposited, it may be assumed that salt is not present in sufficient quantity to condemn it.

(3) Test for presence of glucose by diluting with an equal volume of water and then boiling it with some fehling solution. If sugar is present the blue colour is destroyed, and a red precipitate is produced.

(4) Test for lime by adding some crystals of ammonium oxalate to some which has been diluted with twice its own volume of water. Shake well at intervals, a white precipitate indicates the presence of salts of lime.

Glucose. ($C_6H_{12}O_6$)

Glucose is a term indicating a variety of kindred shbstances of a similar general character, and consisting chiefly of the essential constituents of sugar. It is however usually employed to signify that specific variety of glucose termed 'dextrose' also 'grape-sugar' and 'starch-sugar.' The glucose of commerce is manufactured extensively from different varieties of starch,, and used in some trades as a substitute for pure cane-sugar, and also as a substitute for glycerine in size mixing. Glucose bears close resemblance to glycerne, but it is more viscouse and of much denser consistency than that substance.

It is yellow to brown in colour and solid, but not so sweet as sugar-cane. Boiled with fehling solution a bright red precipitate of cuprous oxide is formed.

Glucose in Sizing.

Glucose has hygroscopic and lubricating properties and therefore acts as a softener. It has adhesive properties and therefore increases the size retention and helps the weaving.

Glucose has many valuable properties in finishing and is extensively used as a softener for preventing the starch becoming stiff and harsh. It adds smoothness and a mellow feel to the cloth and produces a lasting finish.

Glucose is frequently used in conjunction with Epsom salts and Glauber's salts in finishing of woven coloured goods.

It is supplied with a specific gravity of 45° Be, and requ res diluting with hot water, in order to allow the liquid to be poured easily nto the size mix ng. The usual method is to weigh the required quantity of glucose in buckets or in suitable receptacle and add a little hot water, when it will readily dissolve. It should be added to the size at the same time as tallow. In place of tallow, etc. Glucose should be used pound for pound. The only thing that should not be used in the size with glucose is Alkali (whether caustic soda or any other) as they would have a caramelizing action and turn the colour slightly.

'**Stearine**' is the principal constituent of hard fat, such as tallow and suet, and it also occurs in some varieties of vegetable fat and oil such as cotton seed oil. It consists essentially of a base of glycerine, palmitin, or olein, in amalgamation with a fatty acid termed stearic acid. Thus a glycerine with stearic acid produces a glycerine stearate compound.

It has high saponification value. It imparts pliability to the yarn due to its obegenous character. It imparts lustre to the calendered goods.

In preparing stearine for use in size mixing it should first be flaked and boiled for a short time in water in proportion of approximately one part of stearine by weight to 10 parts of water. The boiled stearine should be added to the size mixture when the starch and other ingredients have reached gelatinisation point.

Or, Take (1) 1½ Gallons of water.

(2) 1 lb. Caustic Potash.

(3) lb. Stearine.

Mix 1 & 2. Melt 3 and mix with 1 & 2. Stir well while mixing. If stearine is used on a yarn sized with pure farina would produce an effect more remarkable than that of paraffin wax. There is no doubt that pure paraffin wax or pure stearine are most powerful protective agents when applied to a dried sized yarn.

Soluble oil

It is virtually soap water produced by saponifying oil by the action of caustic soda, as in soap manufacture, and afterwards adding water approximately in the following proportions, by volume 25% oil. 5% caustic soda at 50° Tw. (R.D. 1.25) and 70% water. The oil and caustic alkali solution first be combined and boiled together very thoroughly to ensure complete saponification of the oil, after which the water should be added at a high temperature to prevent the emulsified oil congealing into solid lumps of hard soap. For sizing purposes the oil selected should be of vegetable origin, as castor oil, olive oil, or palm oil. After being treated in the manner desired, the material becomes soluble in water, and combines freely with it.

A variety of soluble oil sold as 'glenic oil' is prepared from olive oil, and used for sizing purposes. But it is important to bear in mind that soluble oil of any description should not be used as an ingredient of size mixing containing chloride of magnesium, calcium, or zinc, etc., owing to their detrimental effect to the caustic alkali which is present in the soluble oil.

Turkey red oil

This oil is prepared by treating castor oil with strong sulphuric acid. It is frequently used as a softener in finishing and occasionally in size mixing. It is also used in a damping mixing as a help towards obtaining lustre.

How to prepare turkey red oil

Run 40 gallons of castor oil into a lead-lined tank, containing an agitator and into this 10 gallons of sulphuric acid, of 170° Tw. should be poured in gradually. Stir continuously. The mixture is allowed to stand for 12 to 14 hours, after which a solution of common salt, of about 8° Tw. is run in, well mixed, and again allowed to stand. The fatty acids will aggregate, and collect at the surface of the salt liquor. This liquor is then drawn off by means of a tap placed near the bottom of the tank. The operation of salting is repeated, and

the mixture again allowed to settle, the salt liquor being drawn off as before. By the time the second washing has been completed practically the whole of the sulphuric acid should have been removed. It is now necessary to neutralise the free acids and make up to the desired strength. Caustic soda is usually the alkali employed for this purpose. When the fatty acids have been neutralised the Turkey Red Oil is diluted to a certain Strength (50% oil and 50% water or 60% oil and 40% water) with water.

Sperm oil

This liquid wax is obtained from the blubber or from the contents of the cranial cavity of the cachalot whale, the latter product differing in many respects from the former.

It is a pale yellow oil, which is nearly odourless when pressed from fresh material. It is a valuable lubricant, since it shows no tendency to become viscid on exposure to the air. It is sometimes adulterated with low grade fish oils.

Arctic Sperm oil

Arctic sperm oil, also sold as bottlenose oil, is obtained from the bottlenose whale, and resembles ordinary sperm oil in its chemical and physical characteristics. It is used as a lubricant.

Neats-foot oil

It is a pale yellow and very fluid oil, derived from the 'feet' (hoofs and hocks) of various animals (oxen, horses, sheep). It is used as a lubricant as well as for steeping loom pickers.

Soap

Soap is a substance which has been known from very early historical times—we find it mentioned in literature which is over 2000 years old, and during recent years a soap factory has been discovered in the remains of Pompeii.

Sizing soap of several varieties is prepared specially for use in size mixing and is employed with the object of assisting the tallow or other fat to dissolve and emulsify more thoroughly, and so enable to combine more freely with the other ingredients to produce a size paste of a more homogeneous constitution. It also causes china clay to boil down to a thinner consistency and prevents it from spurting up and splashing in the pan during boiling. The particular object

in view in the manufacture of sizing soap is to produce soap in which the caustic alkali employed in its manufacture is properly fixed or neutralised so that there is no trace of it left in a free uncombined state. Soap of any description, however, should not be employed in conjunction with chloride of magnesium, zinc, or calcium, nor with sulphate of magnesium. Otherwise the size will become lumpy.

As previously stated fats and oils are composed of fatty acids and glycerine, caustic soda, and other caustic alkalies decompose this combination, the alkali combining with the fatty acid to form soap, and liberating the glycerine. Other substances have the power to bring about this reaction, such as carbonate of calcium commonly called lime, but these produce insoluble soaps and are therefore useless. A good example of this is the production of scum when washing with soap in hard water. Hard water contains lime, and this acts upon the fat in the soap to produce the insoluble soap, or scum, which is so well known. There are two kinds of soap, hard soaps and soft soaps. Hard soap is manufactured by placing in a large boiling vat the fat, and the caustic lye added to it, the whole then being brought to a boil. Soap is added to emulsify the fat to assist it to combine with the alkali. After boiling for a few hours a common salt is mixed into the mass, causing the soap to separate from the water and rise to the surface. This action is due to the fact that soap is insoluble in a salt solution. The water is then drawn off and a fresh supply of caustic lye added and the boiling process repeated after again treating with salt, the soap is removed from the surface and dried.

Soft soaps are produced by boiling such oils as hempseed and linseed oil with caustic potash. Soft soap produced from hempseed oil is green, whilst that from linseed is brown. It is not often that soft soap is adulterated with excess of water, for this would show itself at once by causing the soap to be thin. This soap cannot dry up, as the tendency from them is to attract water. On the other hand, hard soaps readily dry up, and lend themselves far more readily to adulteration.

Soap containing silicate of soda should never be used in sizing. A cold process soap is best, as these contain most glycerine. Castor oil soap is probably the best of all sizing soaps.

Impurities in soap

Great care should be taken in purchasing the materials used in size mixing, not only because of the risk of obtaining an agent that will injure the yarn, but also because of the possibility of obtaining

an inferior article. A great deal of inferior work is done if a soap contains resin, potato starch, salt, clay, fuller's earth, chalk, or other impurities, as they are not only useless, but wasteful, and also assist materially in forming a scum.

The testing of soap should include the following determinations:-

(1) *Water.*—Take a sample from the middle of the bar if hard, or below the surface if soft. Weigh quickly on a tared watch glass and then shred it if hard soap, and dry in an air oven at a temperature of 105° C. till no further loss in weight occurs. Calculate to a percentage.

(2) Find the amount of ash.

(3) *Fatty Acid.*—Weigh out 25 grams of the sample and dissolve in a beaker of water on a water-bath. When it is near boiling point add a few drops methyl orange and then strong hydrochloric acid till the indicator has turned into a distinct pink colour. This liberates the fatty acid. Boil gently till the acid forms as an oily layer on the top of the liquid. Add 5 grams of stearic acid or paraffin wax, warm up until the two are thoroughly mixed, and then allow the vessel and contents to cool. Carefull remove the cake, dry on filter paper, and weigh. Deduct the weight of wax (which was added to ensure that it set solid) and calculate to a percentage on the amount of soap used.

On a small scale soap may be prepared in the following ways :—

(1) Shake up ammonia with olive oil—a white solid results which is largely soap—say 8 ozs. of olive oil, 2 ozs. of concentrated liquid ammonia.

(2) Make a strong solution of caustic soda, add this to palm oil, stir well and allow it to stand. In a short time the temperature rises and solid palm oil soap is formed. This is known as the "Cold Process" of soap making.

(3) Make a solution of tallow in alcohol, add some caustic soda previously dissolved in water, and simmer on a water bath for half an hour. Add salt to the liquid, and soap is precipitated from solution.

(4) Cold process soap :—

8 lbs. cocoanut oil
1 lb. groundnut oil
20 ozs. (fluid) of C. soda lye 39°B
½ oz. citronella

Mix the C. soda lye with cocoanut oil gradually, but stir well, and as it begins to thicken up add the citronella and pour into a mould and let it stand until hardens up and then cut as required.

(5)	Cocoanut oil	300 lbs.
	Soda lye (38°B)	150/160 lbs.
	Salt solution (18°B)	30/150 ,,

or,

(6)	Cocoanut oil	300 lbs.
	Soda lye (39°—40°B)	150 ,,
	Potash solution (20°B)	25 ,,
	Salt water (16°B)	12 ,,

In the above two formulas the oil is melted at about 80° Fah. and 135 lbs. of the lye agitated or stirred in, when the mass is thickening the remainder of the lye mixed with salt solution is added. If some castor oil is preferred in the soap, it may be added to the coconut oil and the filling may be varied according to the following formula :

(7)	Cocoanut oil	300 lbs.
	Castor oil	30 ,,
	Soda lye (38°B)	162 ,,
	Potash solution (20°B)	24 ,,
	Potassium chloride solution (15°B) ..	18 ,,

(8) **Castor oil soap**

caustic soda (solid)	= 1lb. 3 ozs. 87½ grs.
Water	= 1 gallon.
Castor oil	= 10 lb.

Mix caustic soda in 1 gallon of water. Slowly add caustic soda liquor to the oil, while doing so stir the oil briskly. Then let it stand for a day, with an occasional stir. It is then ready to be used.

(9) **Soft soap**

10 lbs. Linseed oil.
20 ,, Caustic Potash at 24° Tw.

Add half the quantity of potash to 5 lbs of water. Then boil for a little while. Add furter half of the remaining quantity of oil gradually.

If it gives a whitish appearance add more potash and if it is like water or the paste is too thin add more oil.

Caustic soda

Caustic soda is very hygroscopic in air, forms strongly alkaline solution, gives intense yellow colour to Bunsen-flame.

Twaddle for Caustic soda

Pure cocoanut oil	= 72°
Other oil mixed with Cocoanut oil	= 70°
Groundnut oil	= 68°
Castor oil	= 68°

In warm weather the oil does not need heating up. But in winter it should be warmed up to 95° or 98° Fah.

Brown sugar

By adding 1 lb. to each mixing it imparts elasticity to the yarn and improves weaving.

Chloride of magnesium, deliquescent ($MGCL_2$)

It is commercially produced by the action of hydrochloric acid on a base of magnesium metal. As a deliquescent, however, it is greatly inferior to glycerine and far more dangerous as a sizing ingredient if not used judiciously.

It is used as a moistening substance in conjunction with weighting materials such as china clay. The action of this substance tends to cause mildew of the starch and flour by attracting moisture to them. On account of this it becomes necessary to employ a genuine antiseptic in the form of chloride of zinc to counteract this tendency to mildew.

It is bought as a rule in the solid form. To make a solution holes are bored in the cask on the opposite sides and a small swivel pipe inserted in one of the holes (generally in the centre of the cask) through which steam is passed, and as it condenses, the chloride of magnesium is dissolved. The solution is allowed to run into the tank below provided for its reception. The tank should be lined with lead.

The solution of chloride of magnesium should be twaddled at 58° Tw. = 12.90 lbs. per gallon (if not used in Solid);before drawing from the tank stir well and also each time before twaddling. The

temperature at which the liquid is tested, that is to say, whatever figure is chosen to be most practicable, should be closely adhered to in all future mixings, the reason being that heat expands the liquid, and that, as the hydrometer displaces its own weight, the volume displaced must be larger when the liquid is hot owing to this expansion the hydrometer sinks lower into the liquid. It will crystallize if it twaddles above 65°. If the twaddle be too high water should be added carefully until it is of the required specific gravity.

Beware of Excessive use of Chlorides

If too much of chloride of magnesium is used in a mixing it makes the cloth damp. Also it discolours (that is, turns it darker) the cloth within a short time. The use of chloride of magnesium should be entirely avoided in pure mixing though at times it is used in light sizing in order to retain the lustre of the yarn (coloured) by avoiding the use of a mixing which contains china clay and yet retains a weight intermediate to the pure size and china clay mixing as much as possible. Goods that have to be subjected to heat, as in calendering, chloride of magnesium should never be used, if possible, as tendering of cloth and caking of size on the calendar bowls will be the result, as it liberates hydrochloric acid. Never entirely substitute chloride of magnesium for tallow in a mixing, as this will lead to rusting of the metal work of the loom, causing iron stains on the yarn. The tallow prevents this by lubricating the parts that would otherwise become rusty.

Magnesium chloride should be used with discretion, because when heated to comparatively low temperatures, it partially decomposes to give hydrochloric acid. This may occur on overheated cylinders in a slasher machine, and give rise to tender warps.

A warp protected by a deliquescent will not bake as easily as one not so protected on the slasher cylinders. The baking, of course, makes it so brittle that no amount of moisture added by the best humidifiers will bring life back to it, for it is not enough to add tensile strength to the warp, we must also make it elastic. Tensile strength without elasticity will not protect a warp satisfactorily because the longitudinal pull is only one of the strains a warp must resist. Against the bending and the friction caused by the shuttle, the warp must possess elasticity and pliability, and these are quite as important as mere tensile strength. There is no good way of measuring elasticity, and this is best shown by production figures.

Great annoyance and anxieties which cold weather produces to manufacturers on weaving are obviated to a large extent by the use of this salt.

Its great value depends upon its high deliquescent property. If a small quantity be exposed to the atmosphere it will absorb moisture at such a rate as to soon become a liquid. This shows that when used as a sizing ingredient, it will in most states of weather preserve the yarn moist, soft and flexible, the best condition for weaving.

The object in using chloride of magnesium in size mixing is to maintain the percentage of moisture in the sized yarn at, as nearly as possible, the moisture content of the natural cotton, that is, 8 to 9 per cent. Care should be taken to purchase it free from oxide of iron which tinges it yellow, and from the sulphates and chlorides of potassium and sodium, and especially chloride of calcium which would have detrimental results. Chloride of magnesium should not be used in conjunction with soap, as the two chemmically act upon each other producing an insoluble compound (magnesium soap) which is detrimental to the size.

There is also a danger of iron stains if the amount of tallow be reduced below the necessary proportion.

An additional adhesiveness is given to starch by boiling with strong solution of chloride of magnesium. It is not obtained if diluted solution is used.

The following tests will help in detecting any foreign agent contained in chloride of magnesium :—

(1) Pure chloride of magnesium should contain 80 to 90 cer cent of magnesia.

(2) An addition of any mineral acid to the salt will give rise to an effervescence indicating the presence of carbonates.

(3) Presence of potassium chloride is determined in the same way with a violet colour as the consequence.

(4) If common salt be present a platinum wire dipped in the chloride and held up in a non-luminous flame will present an intense yellow colour.

A portion of the chloride of magnesium is dissolved in a test tube, with as little distiled water as possible. To this solution should be added twice its volume of strong hydrochloric acid. The mixture should be well shaken up. If salt be present as an adulterant, it will be precipitated, on account of the insolubility of common salt in hydrochloric acid.

A regular complaint was raised once between a weaver and a finisher. The finisher blamed the weaver for the caking of size on the calender bowls, which he attributed to be due to faulty size. But eventually it was found that the fault was lying in the washing of the calender bowls, which were washed while in motion by throwing at them soap and water. But when the calender bowls were rubbed well while they were stationary with old healds dipped in a weak solution of washing soda and water, and then the bowls were washed with water only while in motion, not only a good surface and feel were obtained but retained the size in the cloth also.

(5) *For sulphates.*—A small portion of the salt is dissolved in distilled water and filtered if not clear and then add a few drops of hydrochloric acid and barium chloride. If a white precipitate is formed then sulphates are present.

(6) *Chloride of Calcium.*—It is found in liquid substance. Such liquids are cheap but found containing very objectionable impurities. It can be tested by adding chloride of ammonium in excess, then a few drops, and a white precipitate of chloride of calcium will be found.

(7) *Iron Salts.*—The solution should be kept open in a glass beaker, care being taken to avoid dust, then the presence of iron will be shown by a brownish red precipitate. Ferrocyanide of potassium or sulphocyanide of potassium may be used. The first gives a blue colour or a blue precipitate according to the amount of iron and the latter gives blood-red colour with soluble ferric salts in the presence of nitric acid. Logwood solution if added gives dark blue colour if iron is present. The presence of acid should also be tested by means of litmus paper.

Calcium chloride ($CaCL_2$)

The substance is sometimes used for sizing purposes, being mixed with chloride of magnesium in equal proportions. It is obtained as a waste product from bleach works, or it can be produced by neutralizing hydrochloric acid with lime. In the chloride produced by this latter method, traces of free acid and salts of iron are to be found, and these should be removed before using it in a mixing.

Commercial calcium chloride in air saturated with moisture will absorb more than its own weight of water, and will retard very considerably the evaporation of water of its solutions. If Epsom or Glauber's salts are employed chloride of calcium should not be used, as these salts should be decomposed.

Unlike chloride of magnesium, calcium chloride does not decompose when subjected to heat, and when used alone is suitable for fabrics which are to be calendered. It is not very suitable as it gives a harsh feel to the yarn.

It must not be present in mixings that contain soap.

Antiseptics

Organic Substances—Pheuol (carbolic acid) and Sodium phenate, thymol, Cresylic acid, and Salicylic acid.

Inorganic Substance—Zinc chloride, zinc sulphate, copper sulphate, sodium fluoride boric acid, and sodium silico-fluoride.

In the case of 'antiseptic' a question arises which is advisable to use ? It is often by no means an easy one to answer. The action of antiseptics has not been thoroughly explained; all that can be definitely stated is that they appear to be substances which are capable of either killing low forms of life or bringing about suspended animation.

In their presence, even if all the conditions conducive to a successful growth are fulfilled, multiplication does not take place or is very considerably retarded.

Some chemicals are more potent in this direction than others, and thus we find that ultimately fermented flour will mildew in spite of the presence of the antiseptic bodies which have been produced.

In the case of dry starch, it is found that no fermentation takes place, but a starch paste will mildew. All natural starches contain some nitrogen compounds, and the plant probably first feeds on these; later the constituents of the starch, in conjunction with the nitrogen of the air form a sufficient soil.

The action of caustic soda as a 'preservative' (it can hardly be called an antiseptic) when boiled with the starch to form the paste is probably due to its destructive action upon nitrogenous matter, so reducing the available food. Size and sized goods always contain water, cotton itself is hygroscopic, and will abstract moisture from the air, and deliquescent bodies like calcium and magnesium chlorides add greatly to the liability. Therefore the greater the amount of water or deliquescent present in the size or on the yarn and cloth, the larger is the amount of antiseptic required in order to prevent the formation of mildew.

Zinc chloride—Antiseptic ($ZNCL_2$)

Zinc Chloride was first prepared as early as 1648, but it was not till nearly 200 years later (1838) that Sir W. Burnett patented a 2 per cent. solution for the purpose of steeping timber and sail cloth in, the solution being known for many years as Burnett's Disinfecting Fluid. In 1870 the strength of zinc Chloride solution in common use for sizing purposes was from 30 to 40 per cent, and it was often contaminated with many undesirable impurities and adulterants, bearing very little resemblance to the ordinary commercial article of to-day. Zinc chloride is really a survior of the fittest.

Sizers know that the flour which has been fermented for a reasonable time is less liable to mildew than a paste which has not been fermented. The explanation is that some of the substances which are the products of fermentation are slightly antiseptic in their nature.

An antiseptic is a substance which by its presence prevents the growth of low forms of animal and vegetable life. Many substances are known to act in this manner, amongst which are zinc chloride, mercuric chloride, copper sulphate, carbolic acid (phenol), iodoform, formalin, glycerine, etc.

Zinc chloride is a white or greyish white mass or powder, with a specific gravity of 2.9. It is highly hygroscopic and deliquescent, an excellent permanent antiseptic germicide, disinfectant, and deodorant. It is employed chefly with the object of preventing and checking the growth and development of mildew. The nitrogenous character of flour makes it apt to decompose, and this decomposition becomes more rapid by the use of deliquescent substance. It also increases considerably the weight of yarn, and cloth, and, by absorbing moisture from the atmosphere, it prevents it from becoming too dry. If cloth was only exposed to dry, warm atmospheric changes in humidity, becoming alternately dry and damp, it is essential to apply it judiciously.

Zinc chloride is obtained by chemical treatment of zinc scraps. The crude solution is treated with sodium carbonate and mixing with bleaching powder to precipitate iron and manganese. The clear solution is siphoned off and boiled down in enamelled iron pots. The evaporation is continued until a temperature of nearly 470° F. is reached. Before the fused mass solidifies, it is run into steel drums which are immediately sealed.

In its commercial form chloride of zinc is liable to contain traces of iron in solution as ferrous chloride, which constitutes one of the most objectionable impurities that can occur in zinc chloride intended for sizing purposes, also, zinc chloride should never be allowed to come in contact with iron, as it readily attacks and rapidly begins to absorb and retain that metal in solution.

Commercial zinc chloride is seldom pure, as the cost of removal of all impurities would make it a very expensive chemical, nor is it necessary for sizing purposes that this highest degree of purity be attained. It is sufficient as a rule that free mineral acid and iron be absent, and that less than one per cent of sodium chloride be present.

Cause of iron mould

Hence if chloride of zinc which is contaminated with iron is employed as a sizing ingredient, the iron is liable to oxidise on the yarn and cloth if these are exposed either to a moist atmosphere, or water, thereby involving the risk of causing iron mould to occur in the form of dark buff coloured stains distributed uniformly throughout the material affected by it. To reduce the risk of the yarn and cloth, developing the stains of iron mould from the use of zinc chloride, add a little common soda in the size—$\frac{1}{4}$ to $\frac{1}{2}$ per cent on the weight of flour is ample, otherwise if used in excess zinc carbonate will be formed, thereby rendering the zinc to precipitate, and thus all its effects will be lost.

How to test chloride of zinc

A good test for the presence of iron, in zinc chloride solution is to add to a small quantity of that substance in a test-tube, a little solution of yellow prussiate of potash. If there is any trace of iron present in the zinc chloride, it will be deposited in the form of a blue precipitate which becomes darker if allowed to remain.

A simple test is to pour some of the zinc into a large glass vessel and allow it to stand exposed to the air for a few days. If iron in any great quantity is present, the liquid will turn brown, and should on no account be used.

Another test is to boil a few drops with pure nitric acid and then add one drop of it (on the end of a glass rod) to some potassium thiocynate solution in another test tube. The production of a blood-red colour shows the presence of iron. The depth of the colour depends upon the amount of iron in solution—if it be but faint the sample may be passed as fit for use.

Substances employed to adulterate chloride of zinc are chloride of sodium, chloride of magnesium, chloride of calcium, chloride of ammonium, sulphate of soda and chloride of iron.

Chloride of zinc is also liable to adulteration with common salt, but if the amount does not exceed 2 to 3 per cent, it is disregarded and not considered to be an intentional adulteration.

Take a piece of dark board, oak preferred, part of the head of a cask will answer the purpose remarkably well and after washing quite clean and drying, pour upon it a small quantity of the chloride of zinc to be tested and place to dry in a warm situation before the fire will do. As soon as the chloride has partly evaporated and partly absorbed into the wood, pour a little more on the same place and replace the wood in the warm situation until apparently dry again. It will be observed that the chloride of zinc containing any salt will leave a white mark, sparkling with crystals, whereas the pure article leaves nothing but a dark looking wet stain. If the board be now removed from the heat, and left for a short time, the pure chloride of zinc will be found very wet, whereas the one with salt remains in much the same condition.

Another test for salt or sodium chloride is to pour some into a test tube half full of strong hydrochloric acid, and after mixing allow it to stand for half an hour. If salt be present to a greater extent than one per cent it will be precipitated in small white crystals.

An adulterated chloride of zinc is a very dangerous substance to use in sizing, as cases of mildew have been known to occur in spite of its use.

Ammonium chloride, of present in chloride of zinc, may be detected by adding to a small quantity of that solution, a strong solution of caustic soda, and boiling them in a test tube, when the presence of ammonium chloride will be indicated by the characteristic fumes of ammonia that are emitted. Also it can be detected by holding at the mouth of the container a piece of red litmus paper, the gas will turn it blue.

Weight of zinc per gallon

When chloride of zinc is employed as an ingredient of size for heavy sizing, it is generally used in the form of a strong solution of about 102° Tw. (R.D. 1.5) containing about 47 per cent solid crystal chloride and 53 per cent water by weight and forming what is termed

a 47 per cent solution weighing 15½ lbs. per gallon. At that density it may be employed in the proportion of about 22 per cent of the weight of the flour or 1.428 gallons per 100 lbs. of flour.

If, however, the yarn or cloth be subjected to either a damp atmosphere, or to intense heat as in slasher sizing, calendering, etc., the amount of chloride used should be reduced or prefereably entirely avoided, in order to avoid the liberation of free hydrochloric acid which is liable to attack or decompose the yarn, thus making the cloth tender and weak.

The impurities in chloride of zinc can be detected as follows:— Zinc should be clear and transparent.

To Test for Free Acid.—The indicator used must be either congo red paper (which is turned blue), or methyl orange solution (which is turned pink) by free mineral acid. As a rule the manufacturer tries to produce a solution which is slightly basic in character, that is, it contains a little oxychloride of zinc in solution.

Chloride of Calcium.—This substance has no antiseptic properties, and is undesirable, apart from its use as an adulterant for chloride of zinc. It not only encourages mildew, on account of its deliquescent properties, but also decomposes Epsom and Glauber's salts. Thus if present in chloride of zinc, chloride of calcium can cause considerable damage. To test for this substance place a small quantity of the zinc chloride into a test tube, dilute with about twice its volume of water, and add a little solution of ammonium chloride. Strong ammonia is then added very carefully, drop by drop, dissolving the precipitate formed by adding the ammonium chloride. Next add a solution of oxalate of ammonium, and if a precipitate is formed then calcium is present, the quantity depending upon the thickness of the precipitate deposited.

Chloride of Magnesium.—The presence of this impurity can be known by taking a small dilute sample in a glass vessel and adding, drop by drop, strong ammonia and afterwards oxalate of ammonia. If no precipitate be formed, add sodium phosphate when a white precipitate will be the result indicating the presence of magnesium chloride. If the precipitate has already formed before the addition of sodium phosphate it should be filtered and then used as said above.

Chloride of Iron.—If a few drops of nitric acid be mixed with the sample and boiled, the mixture remains unaltered if the salt be free, but otherwise presents a yellow reddish brown colour.

Another good test is to add a small quantity of zinc in a test tube a little solution of yellow prussiate of potash. If there is any trace of iron present in the zinc chloride, it will be deposited in the form of blue precipitate which becomes darker if allowed to remain.

Sulphate of Soda.—Presence of this sulphate is proved by a white precipitate produced on adding to the chloride a few drops of hydrochloric acid to the chloride of zinc and shaken up well. Then, if sulphates are present, a heavy precipitate will form on the addition of a few drops of barium chloride solution.

Advantage of zinc chloride

Zinc chloride is by far the most suitable antiseptic for use in sizing cotton cloth, and unless for some reason this antiseptic was not allowed to be present it would almost invariably be used. Chloride of zinc is used in pure mixings to preserve the starch. If this is not the case, then care must be taken to run the sets practically dry in the tape. In the case of a heavy mixing employing both starch and chloride of magnesium in addition to flour, it must be remembered that the chloride of zinc must be increased to provide an antiseptic for both the starch and the chloride of magnesium.

Each gallon of chloride of zinc weighs about 14 pounds, of which actual weight of solid zinc is 5.6 pounds. Therefore the amount of chloride of zinc required for 100 lbs. of flour $=100 \times 8 \div 100 = 8$ per cent or 1 to $1\frac{1}{2}$ gallons at 102° Tw. for every 100 pounds of flour.

Chloride of zinc acts as a preservative only it is in sufficient concentration proportionate to the quantity of flour or starch present. In other words if this preservative is diluted by the addition of other substances its preservative powers will thus be lowered, and yet retaining its moisture absorbing power which is liable to accelerate the growth of mildew in the bale.

Specific gravity of chloride of zinc

The purity of chloride of zinc can be judged approximately by finding its specific gravity. A high specific gravity indicates chloride of zinc of a good quality, since impurities tend to lower the specific gravity. It may here be explained that the specific gravity of a substance is the weight of a certain volume of that substance divided by the weight of an equal volume of pure water at 4° C. or 39.2° F. In order to ascertain the specific gravity of chloride of zinc, the only

equipment required is a U-shaped tube, into which a small quantity of mercury is poured until it contains sufficient to stand 2 inches high in each arm of the tube. Water is added to one side, and then chloride of zinc to the other until the levels of the two liquids exactly coincide. Then measure as accurately as possible the height of each from the surface of the mercury to the surface of the water and chloride of zinc. In this instance the calculation will be based on inches in height instead of weight. Thus, if the height of water in the tube is 4 inches, and the height of the chloride of zinc is $5\frac{3}{4}$ inches, the specific gravity of the latter is $5\frac{3}{4} \div 4 = 1.437$. A U-tube having graduations marked on the arms, with a zero point for the mercury, is often used to facilitate this method of calculation, which is sufficiently accurate for all practical purposes.

Another method for finding specific gravity

If a bottle holds 25 grammes of water at 60° Fah. and holds 37.575 grammes of chloride of zinc solution at the same temperature, then the specific gravity will be $37.575 \div 25 = 1.503$ from which the degrees Twaddell may be obtained by dividing the figures after the decimal point by 5 thus :— $503 \div 5 = 100.6°$ Tw. conversely, the specific gravity may be found by multiplying the degrees Twaddell by 5 and adding 1000, the specific gravity of water being taken as 1000.

Density of a liquid

The method of ascertaining the density of liquid in degrees twaddle is to multiply the specific gravity by 1000, then subtract 1000 and divide the resultant figure by 5. Thus, to find the density of the chloride of zinc, of a specific gravity of 10.437 multiplyig by 1000 gives 1437 and substracting 1000 from this gives 437; then $437 \div 5 = 87.4°$ Tw. Conversely when the density (twaddle) is known and it is required to find the specific gravity, multiply the degrees of twadddle by $5 = 437$; add $1000 = 1437$, and divide the result by $1000 = 1.437$ specific gravity.

Incompatibles

There are many substances used in sizing which are incompatibles, that is, they cannot be mixed without a complete change taking place in their properties. Therefore the following ingredients must not be used together in the same mixing. Caustic soda with chloride of magnesium and chloride of zinc.

Because precipitation is sure to follow and thus it is rendered insoluble and hence all the deliquescent properties required in the yarn at the time of weaving is lost. In that case it is better to do without it than waste money and labour.

Soaps should not be used with chloride of zinc or chloride of magnesium.

A disinfectant or preservative

A disinfectant germicide or preservative must be used to kill or prevent the development of lower organisms which act injuriously on the warp or fabric. Disinfectants are germicides—that is, they kill low organisms. Antiseptics may only retard or prevent the growth of germs. The choice of a protective agent depends on safety, convenience, economy, and permanent value.

Oxygen peroxide, formaldehyde, and strictly organic antiseptics, are not permanent—that is, they evaporate and although they may sterilise the warp temporarily, most of their effect is lost either in the size at the beck if sufficient steam is allowed to escape carrying the valuable preservative, or at least on the slasher cylinder where they are carried away with the very considerable amount of water that evaporates from the drying warp.

Disinfectants, preservatives, or antiseptics are used against mildew. Mildew is rather indefinite term applied to a variety of vegetable growths named fungi. There are a large number of varieties, differing in form., size, colour, etc. Its presence on cloth is due to excessive moisture and the absence of sufficient protectives.

Spores of mildew are floating in the air in considerable quantities, and it is sufficient for their development to find a resting place with conditions favourable to their growth. Starch paste, a wet-sized yarn, are excellent fields for their development. It takes nearly two weeks for their species of mildew attacking warps to develop sufficiently to be noticed.

Borax ($No_2B_4O_7$)

Borax s sodium borate. The salt is found in India, China, and California. It is a fine white crystalline substance, with a slightly alkaline taste. When heated slowly it loses water, and fuses into a transparent glass. In this state it is used as a glass bead test in the detection of cobalt and nickel. It is used as a disinfectant and it has cleaning properties. The crystals dissolve in hot or cold water.

Boracic Acid (H_3BO_3)

Boracic acid is a white, crystalline, lustrous solid which may be freed from a borate by the action of almost any acid.

Phenol. Carbolic (C_6H_6O)

White crystal with a melting point of 42°C. Powerful objectionable odour. Phenol boils at 180°C; is a powerful antiseptic, but is volatile and cannot be considered permanent. If wheat flour, use 1.0% and for other starches use 0.5%.

Creyslic Acid C_6H_4 (CH_3) OH

It is a liquid with a strong characteristic odour, being a mixture of metaortho and para-cresol. The boiling point is between 185° and 203° C. This is less soluble in water than carbolic acid, and a powerful antiseptic. Creyslic acid has the same virtues and objects as phenol. If wheat flour, use 1%, for other starches use 0.5%.

Salicylic Acid [C_6H_4 (OH) COOH]

Occurs in many plants, especially a methylester in the essence of winter-green, traces of which exist in most wines. Made on a commercial scale from coal-tar intermediates. Slender white crystals, used as a preservative and as basis of azo dyes. Iron salts produce an intense coloration making it inadvisable to use in white fabrics. Although it has very good preservative qualities, its vapour tension is too considerable to make its use advisable where a permanent antiseptic is desired. It is suitable for all classes of sizing. If wheat flour, use 0.5 to 1 per cent., for other starches use 0.3 per cent.

If the material is exposed to heat, moisture or air it should not be used with certain dyes, as it tends to change certain colours, especially congo red. It forms a good combination when glycerine is used as a deliquescent to make its use advisable where a permanent antiseptic is desired. If wheat flour, use 0.5%, for other starches use 0.3%.

Benzoic Acid (C_6H_5 COOH)

It is an organic acid and occurs in gums and fruits, produced synthetically from toluol, a coal-tar derivative. It is volatile even at 100°C. although it boils only at 249°C. It sublimes readily into beautiful lustrous leaflets. It is a powerful antiseptic but shares with other organic antiseptics a tendency to be too readily carried off by steam for use in sizing.

Formaldehyde (CH_2O)

This also has been advocated. It is readily decomposed by heat, and is quite volatile. It is a gas of characteristic odour, of which water dissolves up to 52%. Although a powerful antiseptic, it is very objectionable in the slasher room, as it is extremely volatile and its presence disturbs operators. It is of no practical value as a sizing ingredient.

Arsenious Acid (H_3ASO_3)

It is a powerful antiseptic, but its highly poisonous character debars its use as a sizing ingredient.

Perchloride of Mercnry ($HGLC_2$).

It is probably the most powerful antiseptic substance known, and is also the most deadly of the mineral group of poisons, with the exception of the cyanides.

Thymol ($C_{10}H_{14}O$).

It is derived from the essential oil of the common garden shrub, thyme. It occurs in the form of a white crystalline substance resembling alum, and is said to possess antiseptic properties of equal potency to those of carbolic acid.

Boric Acid (BO_3H_3).

This acid exhibits itself as white flakes, unctuous to the touch. It is readily soluble in water. It is largely used for pure size. It can be used equally well for heavy size. It is powerful in restraining bacteria, if wheat flour, use 3 to 4 per cent. for other starches use 2 per cent.

Snlphate of Copper ($CUSO_4$).

Blue vitriol.—Nothing suitable owing to its tendency to give copper stains.

Sal-ammoniac (Nh_4Cl).

This acid may be used for sizing undyed warps, but its weak acid character necessitates caution in employing it on dyed warps.

Iodoform

Iodoform is much too expensive for general use; it is used in surgery.

Sodium Silicofluoride

is sold under the name of "Salufer." It is a white powder, soluble in cold water, and is of the same strength. It can be used for pure as well as heavy size. It should be used in the proportion of 3 to 4 per cent. on the weight of starch.

China clay

For weighting purposes gypsum and alum were used as early as 1799.

China clay is not a quantity of rubbish as it is generally supposed to be solely introduced for the purpose of weighting, but its unctuous and soft nature is taken advantage of in providing what might be called a soap coating to the warp well adopted for weaving.

It must therefore be of very good quality and colour white and opaque, free from yellowish veins, dry, silky or somewhat soapy feel to the touch and very finely divisible. Above everything else it must be very pure—entirely free from any foreign substance, such as particles of grit, lime, iron, as the first and last named have a filing and wearing action on the healds and reeds.

It also fills up the fibre and gives a feel to the cloth, hard to obtain by other means. It renders the paste of the flour less persistent. It prevents that too powerful shrinking of the size when dried on hot cylinders, which has the effect of contracting the yarn. Its specific gravity also better adopts it for use than many of the heavier mineral substances, such as barytes, etc., as it is less liable to settle or cake.

It is always best to buy fine powdered clay of very superior quality as this will save 75 per cent. of steam and the result will be more satisfactory. It should be sieved before introducing it into the clay pan.

It is an absorbent of moisture, and being easily held in suspension it mixes freely with other sizing ingredients.

Before using china clay, a few simple tests will enable one to estimate the quality of the clay. The best method is to retain a sample of a clay which is known to be of good quality, and then by comparison to judge the quality of the unknown clay—both for feel and colour. The best way to test for grit is to mix a little of the clay with water, and then rub it between the fingers; or, gripping between the teeth will serve the purpose. Another way to detect grit is by

shaking a few grams with water, allowing the mixture to stand for two or three minutes, pouring off the top layer, and examining the sediment. This may be done by rubbing it between glass microscope slides or by examination under the microscope For feel, mix a definite quantity of each clay separately with a definite quantity of water, and then rub between the fingers. All good clays should have an oily feel.

China clay is often given a good white colour by adding blue. This can be readily ascertained by treating a small quantity of the clay with ammonia, when the natural colour will at once be restored. If the whiteness is unchanged, the clay may be regarded as of good quality. The objection to tinted clay is that after weaving, yarn so treated will assume, on exposure, the colour of the natural clay, giving an undesirable colour to the cloth. China clay of inferior quality may also be bleached to give it a good colour. Acids are sometimes used for this purpose, and if clay containing acids, especially mineral acids, is used for sizing, serious damage may easily be caused.

Pure clay is soft, more or less unctuous to the touch, white and opaque, and when breathed upon emits a characteristic odour. It may be converted by water into a doughy, tenacious and plastic paste, insoluble in water. Pure clay-fuses with difficulty in the most powerful furnace. It dissolves with difficulty in borax, producing a semi-transparent glass. It forms with carbonate of soda a green glass, if ignited with solution of cobalt, it assumes a blue colour. Clay is soluble, to a certain extent, either by nitric acid or dilute hydrochloric acid, but boiled with strong sulphuric acid until the acid begins to evaporate, the alumina is dissolved out together with a small quantity of silica, and separates the greater portion of the silica in the more soluble condition in which it dissolves in a boiling solution or carbonate of soda, the quartz, sand, felspar, etc., frequently mixed with the clay, remain behind.

The ingredients which most effect the character of the clay are sand, iron, lime, and magnesia, and its plasticity diminishes in proportion to the amount of any one of these substances which it contains. Sand exercises the most marked effect in this manner, lime somewhat less, and oxide of iron very little, but it is not alone in diminishing the plasticity that these ingredients exercise such a very injurious effect when combined with clay used upon warps, and this more particularly, when the chlorides of zinc or magnesia are used in conjunction will entirely decompose these salts, precipitating

their bases and forming chloride of calcium seriously affecting the composition of size, 9 per cent of carbonate of lime is enough to decompose the proportion of chloride of zinc usually added to size.

Great care should be taken to procure a clay as free as possible from lime. Every fresh purchase of clay should be tested with Hydrochloric Acid, when if carbonate of lime is present, the characristic effervescence attending its decomposition is immediately seen.

Clay varies much in quality, some being much more aluminous than others and not so white.

To test for chalk—Filter, and to the filtrate add ammonium oxalate—a white precipitate is obtained if chalk, or plaster of paris, or gypsum is present.

To test for iron—Boil some with hydrochloric acid, filter and divide it into two parts. To one add potassium ferrocyanide—a blue colour is produced if iron is present, the depth of tint depending upon the quantity in solution. A clay suitable for sizing purposes will show only a faint colour.

To the other portion add ammonia and boil. A reddish brown precipitate indicates the presence of an undesirable amount of iron in solution.

Another test, is to mix equal quantities of the standard sample, and the clay to be examined, with equal quantities of water, and allow them to stand for several days. In clays contaminated with iron, a brownish shade is produced by this exposure.

To test for Blue—Take 2 ozs of clay and 2 ozs of water add few drops of strong ammonia and let it stand for at least 12 hours. If the clay is blued, the blue will show itself on top.

Moisture

The amount of moisture present in commercial china clays often varies very considerably. This is due generally to imperfect drying; but even if the clay be thoroughly dried at steam heat, a certain amount of water remains, varying from 10 per cent to 12 per cent, which is only expelled at red heat. For heavy sizing especially, it is very desirable that the sizer should know the excess of moisture above this 12 per cent, which might be called the 'strength' of the clay. This may be determined by drying in a steam oven, or better at 105°C. to 110°C. for several hours, until the loss is constant. An aluminium tray is suitable receptacle to use for the purpose.

The sizer whose speciality is heavy sizing would do well to determine the percentage of 'free' (i.e., expelled at 105°C. to 110°C) and 'Combined' (expelled at red heat) moisture in his various samples of clay otherwise the strength of clay will be reduced due to excessive moisture.

To carry out the test for "free" and "combined" moisture first dry some in a steam oven and find loss per cent. This is "free" moisture.

Next take this steam in dried clay, and heat over a bunsen burner until there is no further loss. This second loss gives the "combined" moisture which should be worked out in percentage.

In fine sizing, that is, when fine yarns are used weighting materials are unnecessary. The addition of weighting materials would destroy to a great extent the usefulness and capabilities of the thread. For weaving cloths of this class the yarn must not be harsh or too soft, but elastic and smooth so that all the sizing process has to effect is, the laying of the loose fibres on the surface of the yarn, and increasing its strength by some pure adhesive preparation.

In preparing china clay first of all it must be broken up into very fine powder free from all lumps and hard substances which can be detected while passing the powdered clay through a fine messed sieve. After doing so it should be mixed in water in a clay pan where a small portion of oil or clay had already been introduced and boiled for a short time. Boil from 4 to 6 hours but during boiling too say 1 to 3 lbs. of washing soda or soda ash be put in to break up the clay further by bringing it to a state of suspension. But bear in mind while adding in the soda if the clay begins to rise very fast the steam must be shut off and it can be turned on again when the clay subsides otherwise all the contents of the clay pan will overflow and thus be lost. Soda must be put in a handful at a time.

Analysis of a sample of cornwall china clay

Silica	= 47.50
Aluminia	= 37.80
Ferric oxide	= 1.05
Lime	= 0.21
Magnesia	= 0.09
Alkalies	= 1.28
Ignition loss	= 12.30
	100.23

French chalk

It has a very smooth feel. It is not as heavy as china clay and does not mix so easily. It is inferior to china clay of superior quality, and is higher in price.

Sulphate of Barium

It is much heavier than china clay but gives too harsh a feel to the yarn and hence it will be too rough on the healds. Used chiefly in finishing cotton goods. It is poisonous.

Talc

This is a substitute for china clay. Smooth and easy to mix, being entirely free from grit. Does not tend to give iron stains by acting on metallic fittings. Helps to give pliability to yarn. Is supplied in a dry state. Has also adhesive properties.

Epsom salt ($MGSO_4$, $7H_2O$).

The chemical name of the substance commonly known as Epsom salt is sulphate of magnesia. It takes the form of long narrow crystals, and is composed more than 50 per cent water. Epsom salt is very soluble in water and is easily absorbed by the cotton fibre, giving a substantial feel to the cloth, and weight without bulk. It also tends to stiffen the cloth. If used in excess, particularly in conjunction with an excessive quantity of magnesium chloride, may crystallise in the warp or in the cloth, and tender the same to a disastrous extent. If a firm feel is desired without the use of metallic chlorides in the size, Epsom salt is valuable.

In any case, chloride of magnesium would very probably be used for such a mixing, and the very small excess supplied by the Epsom salt would have no adverse effect. But if the cloth is to be finished in a manner which necessitates the use of heat, such as calendering, etc., then the Epsom salt used for sizing should contain as little chloride of magnesium as possible. The detection of chloride of magnesium in Epsom salt can be carried out as follows :—

> Dissolve a little of the salt in water, and treat it with a few drops of nitric acid, afterwards adding a small quantity of nitrate of silver solution. A white precipitate is formed, and from the extent of this the amount of chloride present in the salt can be estimated. Comparison with a known good quality of salt is the best method, and this should be retained for the purpose. When testing, always use the same quantities of salt and water.

Glauber's salts

Should never be used in a mixture with calcium chloride. These two salts will react to form chloride of Sodium and the insoluble deliquescent Calcium Sulphate. As the calcium chloride is added because of its hygro-scopic properties, it should be held away from the reagent which changes it to the sulphate, and thereby loses the effect desired. The desired character of the mixture will be entirely destroyed by the presence of any Glauber's salt. Glauber's salts are sometimes used in conjunction with Epsom Salts for coloured goods.

Alum [$AL_2(50_4)_3 . K_2SO_4 . 24H_2O$].

The salts most largely used in sizes are the sulphates. Alum is a double sulphate of potassium and ammonium or aluminium prepared by mixing and crystallizing the dissolved sulphates.

Test for Alum

Soluble in water, giving an astringent taste, yields a white gelationous precipitate on adding ammonia.

Salt (Na CL).

Cubical crystals soluble in water; insoluble in strong hydrochloric acid.

Bleaching powder [Ca (OCL) CL]

Treated with dilute acid, chloride is evolved; very deliquescent as usually met with.

Apparatus and Chemicals for use for Testing Purposes.

Apparatus

Bunsen burner and rubber tubing.
Chemical Balance.
Cheetham's reflector.
Counting glass.
Microscope.
Magnified glass.
Electric reflector.
Heal's yarn gauge.
Lancaster yarn quadrant.
Porcelain basins.

Sets of grain and Metric weights.
Test tubes.
Tripod stand.
Weighing scales or small platform balance.
Watch glasses.
Yard—stick (flat with metal—tipped ends)

Chemicals

Ammonia
Ammonium carbonate
Ammoniacal cupric oxide
Bleaching powder (chloride of lime, or chemic)
B. Naphthol (beta naphthol)
Caustic soda, 5% solution.
Caustic potash.
Cochineal tincture.
Hydrosulphite Solution.
Hydrochloric acid (Spirits of salts)
Iodine crystals.
Lead acetate.
Lithmus paper.
Methylated spirits.
Nitric acid (aqua fortis)
Olive oil
Plumbite of soda
Sulphuric acid (oil of Vitriol)
Salicylic acid, 2% Solution.
Sodium nitrate.
Sulphurus acid.
Zinc chloride.

CHAPTER XXVIII.

THE USE OF WATER FOR SIZE MIXING.

Water is one of the fundamentals of existence as we know of. It comprises three-quarters of the earth's crust and is present in most natural things, in many of them to a very high degree, *e.g.*, fish 80 per cent, animals (including man) up to 70 per cent, plants 50 to 95 per cent, and even in clay up to 14 per cent.

'Water' signifies a colourless, odourless, tasteless liquid, freezing at 32 degrees Fahrenheit and boiling at 212 degrees Fahrenheit, and having other definite and characteristic properties. It is a simple chemical compound containing the elements, hydrogen and oxygen, in the proportion of one part by weight of hydrogen to eight parts by weight of oxygen, and having the chemical formula H_2O. Chemically pure water, however is a scientific curiosity and can be prepared only with great difficulty. Naturally occurring water is always impure, and the impurities contained in it determine its suitability for drinking and industrial purposes. Natural waters differ widely both in regard to the nature and quantity of the impurities present. The impurities may be present in suspension or in solution. Suspended impurities are often regarded as of the greatest importance, because they are readily observed by the naked eye. Their removal, however, is relatively easy. Simple process of sedimentation or filtration, with or without the addition of a coagulant, such as aluminium sulphate, is usually effective and is widely used.

In industrial work the impurities which are present in solution are of greater importance because in the majority of cases their presence does not affect the appearance of the water, and they can be detected and their amounts determined only by a careful chemical analysis.

The existence of dissolved impurities is the result of the remarkable solvent powers which water possesses. Water has been described as a 'universal solvent,' and its solvent action begins when rain water falls through the atmosphere. The gaseous ingredients of the atmosphere—oxygen, nitrogen and carbon dioxide —are dissolved. Oxygen and carbon dioxide which are dissolved to the extent of two

cubic inches and one cubic inch per gallon respectively, are particularly important, because they give to the water greater solvent powers on the mineral matter with which it comes into contact in the earth's crust. Organic impurities and atmospheric dust are also carried down in rain water, especially in idustrial districts. In the large industrial districts, such as Manchester and Glasgow, the rain water when it reaches the earth may be definitely acid. Rain water in the neighbourhood of large towns has been actually found to contain as much as four parts of sulphuric acid per 1,00,000 parts derived from the sulphur gases present in the atmosphere. The presence of acidic impurities of this makes the water corrosive and accounts for the deterioration of stone building and metal work in industrial districts. In spite of the contamination which takes places during its fall through the atmosphere, rain water is the purest form of natural water, especially when it is collected in the open country.

When water falls upon the earth, a part flows over the surface and forms streams which later runs into rivers and lakes, and a part penetrates the earth's crust and percolates through various strata, ultimately appearing again in springs and deep wells. During its contact with the earth's crust, organic and mineral matters are dissolved by the water to an extent which depends mainly on the nature of the strata with which it comes into contact.

The substances taken up by the water may be divided into the following classes :—

(1) Living organisms ;
(2) Organic vegetable matter ;
(3) Mineral matter.

A fresh condensed water, or a good pure soft water, is absolutely essential if the highest results are to be obtained in the textile industry.

Its influence on 'feel' and 'colour' is great, and the change from a hard unsuitable water to a pure, soft, or condensed one will improve the strength and elasticity of the yarn considerably.

Hardness of water

Hardness in water is due mainly to the presence in solution of various compounds of calcium and magnesium. It is customary and necessary to distinguish between two kinds of hardness; (*a*) carbonate hardness and (*b*) non-carbonate hardness.

Carbonate hardness is due to the presence of bi-carbonates of calcium and magnesium. It is for the most part destroyed by boiling, and it is for this reason that it is often called temporary hardness.

Non-carbonate hardness is due to the presence of the sulphates, chlorides, and nitrares of calcium and magnesium. It is not destroyed by boiling at atmospheric pressure, and it is therefore often called permanent hardness.

For correcting water, for every English degree of hardness and for every 100 gallons of water used :—

Take (1) about $\frac{1}{3}$ oz of soda ash, or (2) about $\frac{1}{2}$ of oxalate of ammonia.

To soften water

(1) Add $\frac{1}{2}$ pint of Liquid Ammonia to 10 gallons of water or,
(2) Add 2 lbs. washing soda to 10 gallons of water or,
(3) Add 1 lb. caustic soda to 10 gallons of water.

How to prepare soft water for size mixing

(1) Take water in a tank measuring, say 8'L ×4'B ×6'D.

(2) Let the drawing valve stand higher up from the bottom of the beck, say by 2 feet to allow room for sediment.

(3) The cubical contents of the tank =8′ ×4′ ×6′ =192 c.ft.
192 ×6.25 (galls. to 1 c.ft.) =1200 gallons.
1200 galls. ×10 (lbs. to a gall.) =12,000 pounds of water.

(4) Add $\frac{1}{4}$ to $\frac{1}{2}$% of alum to the water =30 and 60 lbs. respectively.

(5) Allow the sediment to be deposited in the bottom of the tank for about 24 hours. Heat helps sedimentation better and quicker.

(6) Draw clear or soft water as required.

(7) Clean tank before every preparation.

(8) To bleach the water or to remove organic matter use perchlorone 1/20 to 1/10% on the weight of water.

Estimation of water hardness

For estimating the total hardness of water use an alcoholic soap solution containing 20 grms. of neutral pure white olive oil soap per litre, standardised with a barium chloride solution containing

0.523 grms. pure crystallised barium chloride per litre distilled water. This barium chloride solution, which requires 45 c.c.s. soap solution for every 100 c.c.s., corresponds to water of 15° English hardness.

When testing the hardness of water, measure 100 c.c.s. with a pippet into glass-stoppered cylinder or flask of about 250 c.c.s. contents, and allow the normal soap solution described above to flow in until the froth formed on shaking remains standing for about 5 minutes. The number of c.c.s. of soap solution used indicates the total hardness of the water according to the following table. If the water is very hard take 10 or 20 c.c.s. dilute to 100 c.c.s. with distilled water, and titrate as above.

1 English degree of hardness	=1 part Ca CO_8 in 70,000 parts water
1 German degree of hardness	=1 part CaO in 1,00,000 parts water.
1 French degree of hardness	=1 part $CaCO_3$ in 1,00,000 parts water

In order to express the hardness of water quantitatively it is usual to calculate the calcium and magnesium compounds present in terms of their equivalent of calcium carbonate (CaCO). The hardness is then stated in terms of "grains $CaCO_3$ per gallon" (degrees of hardness) or "parts $CaCO_3$ per 1,00,000." The latter method of expression is widely used in this country at the present time.

" Parts $CaCO_3$ per 1,00,000" when multiplied by 0.7 gives the hardness in 'degrees.'

Calcium and magnesium compounds react with soaps in solution forming insoluble soaps which separarte out as a sticky curd-like deposit. The soluble soap which is thus acted upon is of no value for washing and scouring purposes, and the precipitated calcium and magnesium soaps adhere tenaciously to the washed fabrics, forming streaky deposits and causing the colour and 'feel' to be unsatisfactory. A water of hardness equal to 20 parts per 1,00,000 (14 degrees) destroy about 20 lbs. of soap per 1,000 gallons.

Hard waters not only lead to wastage of soap, but also have an adverse effect on the efficiency purposes.

For certain purposes the temporary hardness of the water may be corrected by the addition of acetic acid. The amount of acetic acid required will be seen from the following table.

One litre of water is tinted with a trace of methyl orange and then one-tenth normal hydrochloric acid (10 c.c.s. hydrochloric acid 84.2° Tw. per litre of water) is run in from a burette until it is

decolourized. The number of cubic centimetres of acid used are then found in the first column of the following table and in the same horizontal line is given the amount of acetic acid required to correct 130 gallons of the water.

No. of c.c. $\frac{N}{10}$ acid required per litre of water.	No. of oz. acetic acid 30% required per 100 galls. water.	No. of c.c. $\frac{N}{10}$ acid required per litre of water.	No. of oz. acetic acid 30% required per 100 galls. water.
1	0.32	26	8.32
2	0.64	27	8.64
3	0.96	28	8.96
4	1.28	29	9.28
5	1.60	30	9.60
6	1.92	31	9.92
7	2.24	32	10.24
8	2.56	33	10.56
9	2.88	34	10.83
10	3.20	35	11.20
11	3.52	36	11.52
12	3.86	37	11.84
13	4.16	38	12.10
14	4.48	39	12.48
15	4.80	40	12.80
16	5.12	41	13.12
17	5.44	42	13.44
18	5.76	43	13.76
19	6.08	44	14.08
20	6.40	45	14.40
21	6.72	46	14.72
22	7.04	47	15.04
23	7.36	48	15.36
24	7.68	49	15.68
25	8.00	50	16.00

HOW TO TEST WATER IN A SIMPLE WAY

To ascertain if water is hard

Put a few drops of soap dissolved in alcohol into a glass of water; if the water is hard, it will become milky.

Test for acid or alkali

Dip into a test tube half filled with the water a strip of red lithmus paper; if it turns blue, the water is alkaline. Dip a strip of the blue lithmus paper into the water, if it turns red, the water contains acid. Or place a small quantity in a glass tumbler and add a few drops of methyl orange. If the sample of water is acid, and hence corrosive, it will turn pink. If it is alkaline, it will be yellow. The methyl orange is obtainable as a powder, and about 40 grains should be added to 1 pint of distilled water to make the solution for testing.

Test for carbon Dioxide

Pour about ¾ inch of water into a test tube and then pour in the same quantity of lime water, if carbon dioxide is present, the water will become milky, on adding a little hydrochloric acid, the water will become clear again.

Test of carbonate of lime

Pour some of the water to be tested into an ordinary tumbler. Add a little ammonia and ammonium oxalate, then heat to the boiling point. If carbonate of lime is present, a precipitate will be formed.

Test for sulphate of lime. or gypsum

Pour water to the depth of 1½ inches in a test tube and add a little barium chloride, if a white precipitate is formed and will not redissolve when a little nitric acid is added, sulphate of lime is present.

Test for magnesia

Boil the water to one-twentieth part of its weight, drop a few grains of neutral carbonate of ammonia and a few drops of sodium phosphate into it—a precipitate will be formed if magnesia is present.

To ascertain if water contains iron

Put a small piece of prussiate of potash into a glass of water; if the water contains iron, it will become a blue colour.

To find the quantity of water required for preparing Flour and Clay.

Example :—

Flour vat	$= 8' \times 4' \times 4'$
Clay Pan	$= 4' \times 4' \times 4'$
Quantity of Flour	= 3280 lbs.
Tallow	= 140 lbs.
Chloride of Zinc	= 264 lbs. (solid)
Chloride of Magnesium	= 160 lbs. (Solid)
Total Mark in the Finishing Beck	=28 inches.
Cubical Contents	= 17.25 Gals. to one inch.

Flour and water

20 bags of flour =3280 lbs and 1264 lbs. of ch. of zinc =3544 lbs. Divided into 8 mixings of 5-inches each =443 lbs per mixing $5'' \times 17.25 \times 10 = 862.50$ lbs.

Less =443.00 lbs.

Water =419.50 ,, in the flour vat.

Now, Clay and Water =

Clay + Tallow + chloride of Magnesium =800 lbs.

Water $= 15'' \times (17.25 \times 10)$ =2587.5 lbs.

Water only in the clay pan =2587.5—800 =1787.50 lbs. Suppose now to bring to the total mark of 28 inches in the finishing beck it is necessary to add 8-inches more of water.

$\therefore 8 \times 17.25 = 138$ Gals. $\times 10$ (lbs to 1 Gal.) =1380 lbs.

Total quantity of water used =

In the flour	= 419.50
Clay	=1787.50
The additional 8″	=1380.00
Total	=3563.50

3868.50÷10 =365.35 Galls. app: contained in the mixing exclusive of condensed steam.

The "Injurious Effects of Impure Drinking Water."

The injurious effects of impure drinking water, whether from wells, rivers, ponds, or tanks, are responsible for a very large proportion of the total sickness in India.

Alum for centuries has been in common use in the East for the clarification of water, and is capable of effecting most efficient purification, if the impurities which precipitated are allowed sufficient time to settle down. Its alumina entangles and carries down bacterial and suspended matter alike, leaving the purified water brilliantly clear.

Further, not only is there an enormous diminution of germ life and mechanical impurity, but the precipitated alumina, exciting its well-known action as a mordant or colour percipitant, also removes the objectionable yellow or brown colouration of peaty or surface waters which so much detracts from the appearance of otherwise suitable supplies.

Alumino ferric is usually employed at the rate of about 1½ grains per gallon, and the results, both from the appearance and bacteriological point of view are excellent. The use of alumina as a coagulent is now regarded as essential to the most efficient working of the large majority of installations.

CHAPTER XXIX.

THE WEATHER, WEAVING-SHED, AND ITS SURROUNDINGS.

Considerable diversity of opinion exists amongst both engineers and textile experts concerning the best position and constructional features of sizing rooms, and also the relative merits of different methods of heating and ventilating those rooms in order to ensure the temperature and humidity of the air that will be most congenial both to the yarn for weaving purposes, and also to the peculiar conditions under which the operation of sizing is conducted.

Consequently there are many examples of faulty construction, imperfect methods of heating and ventilating of sizing rooms, in some of which it is quite impracticable to conduct the operation of sizing with reasonable economy and satisfaction. Indeed, success in this direction may be attained only by conforming to such conditions and requirements as are prescribed from definite knowledge of the practical details of the operation of sizing, and also of the atmospheric conditions that are most favourable to its successful accomplishment.

Points to be considered for providing "Humidity and Temperature"

(1) The climatic situation of the factory.
(2) Size of the department and its construction.
(3) Number of persons working in the department.
(4) The space occupied by the machine.
(5) Horse power used by the machine.
(6) Nature of the work done in the department.
(7) The working time in 24 hours.
(8) Season of the year.

Throughout the cotton industry it is generally believed that a fairly high temperature is necessary for the manufacture of cloth. The sheds are constantly kept at a temperature well over 60 deg., and in some cases the average temperature for the year is from 70 to 80 degree. During the hot summer months the shed temperature frequently reaches from 85 to 90 degree. In general it will be found that a rise or fall in temperature in humid sheds is usually followed by a rise or fall in output, due to a reduction or increase in

the number of yarn breakages. In the dry shed there is a slight tendency for the output to decrease as the temperature rises. During the winter months suitable temperature conditions are frequently not reached until after two or three hours of work. A higher initial temperature would undoubtedly give more satisfactory results, since a low temperature means an increase in the number of yarn breakages and consequently more work for the operatives.

How to prepare a size mixing

The great point to be aimed at in preparing a mixture in addition to adding the necessary weight to the warp the mixture permeats the yarn and becomes firmly fixed to it. If the materials are not thoroughly incorporated and secured, then a large proportion will be rubbedoff in the weaving, hence the results aimed at are not obtained.

Change the Mixture with the Weather

A size which will become well fixed in a moist atmosphere may not adhere securely to the yarn in a dry atmosphere. This is one of the great difficulties in the process of sizing as carried out in some parts of India. Some districts have a very dry atmosphere all the year round, others again have a very dry atmosphere in the hot season and damp one in the monsoon. There are also some districts that have a moist in the hot season and monsoon and dry in the cold season. It is much easier to apply and fix the size in a low temperature than it is in a hot dry one. In the case of the former a much less weight of softeners are used and in moist cases no deliquescents or very little should be used. Whereas in the case of the latter an increase in softness and application of deliquescents are required if the yarn is at all to be kept soft and pliable.

It is obvious that those entrusted with the management of size mixing must vary the mixture with the weather, particularly, if it is of changeable character and also if the weaving shed is not provided with an efficient arrangement of heating and humidifying.

Conditition of the Atmosphere

It is necessary to ascertain whether the country has four distinct seasons: winter, summer, spring, and autumn, or a climate like that of Madras, warm, or two distinct seasons, one cold dry winter, and a hot dry summer like that of U.P., Cawnpore, Lucknow, etc., or mild damp atmosphere like that of Bombay and very damp atmosphere like that of Bengal. A size which is good for Bombay will not be good for Madras or U.P., and a size which is good for winter season will not be good for summer.

The seasons

Hot, Dry Summer Weather—During this season the dry bulb thermometer often rises to nearly 150° Fah. in the sun, and the outside humidity is very low.

The Monsoon Weather.—During this period the outside humidity often rises to nearly 100 per cent.

The Post Monsoon Weather.—At this period, rapid changes of both temperature and humidity are experienced.

The Winter Weather.—During this period it is often necessary particularly at night and early morning to add heat to the department to keep up the temperature.

The site of a mill is a very important factor as to whether the mill is situated in a damp or dry area, near a river or a dry plane.

The sea side factories give better natural humidity than those situated for away from the sea.

In day time naturally the heat begins to increase from morning due to the radiation of sun. This case is not present at night time. The variation in temperature during the day and night vary in different seasons and in different districts. The average might be from 8 to 15 degrees.

It is a well known fact that the condition of the atmosphere has a great influence upon the weaving of cloth, and further, that the condition is not only dependent upon the weather, but also upon the locality, surroundings of the weaving shed, as well as the type of roof of the weaving shed whether it is a tile one or built with corrugated iron sheet or whether it is a saw-toothed shape or a flat roof.

Constructional Difference

The constructional difference is also important as can be seen from the following table of the transference of heat per B.T.U. per sq. feet per degree of difference between the room and the outside temperature per hour.

14″ thick brick wall	0.31
18″ „ „ „	0.26
24″ „ „ „	0.21
Roof of corrugated iron sheets	1.00
Roof of wool ceilings and tiles	0.36
Roof of corrugated sheets and tiles	0.74
Window glasses	1.00

Add 10 per cent. per southern and Western exposures.

Heat given off by the human body.

An average adult breathes 18 times per minute and draws 25cu. ins. of air. This gives 15.6 cu. ft. per hour and the air exhaust from the lungs contains 5 per cent. of Co_2. The standard of purity of air as infixed in air the Co_2 must not be present above nine volumes per 10,000 in mills where artificial humidity is practical which works out at 15,000 cu ft. of air per hour per each operator. This concerns only for the Co_2.

The heat given off by the human body must also be taken into consideration, and if this heat is not absorbed by the surrounding air, perspiration settles on the skin and cools the body. The consequence is more energy is required to maintain the temperature of the body. So the plant must include cooling and ventilating devices. In order to find out how much quantity of air is necessary the cubical contents of the building will have to be found out. This will be the total cubic contents of the buildings minus that occupied by the machines. The next consideration is the heat developed due to the horse power used for the machines will be 778 h.p. B.T.U.'s.

Adverse effect of hot weather.

Hot weather conditions in weaving shed has an adverse effect on the sickness rate. The combination of high temperatures and high humidity is most distressing and uncomfortable. White-washing or preferably white-painting the roofs and the window panes would effect reduction in temperature, to about 3°F. which was actually experienced by the author after taking several tests.

Conditions of air and humidity.

The conditions of the air which affect weaving are the quantity of vapour contained in it (air) which varies greatly with the seasons, the climates, the temperature, etc. The physical laws of air or gases will show how these produce their effects. At 60° Fah. air can only absorb 5.8 grains of aqueous vapour per cubic foot of air, whilst at 86° Fah. it can absorb 13.2 grains per cubic foot and so on to a greater degree in proportion to every degree rise in temperature. It follows then that when air contains its maximum content of water, that is, in a saturated state and is cooled, a separation of some amount of water must take place in the form of fog, or condensation. Taking air at the temperatures quoted, in cooling from 86° to 60° Fah. there is separation of 13.2–5.8 =7.4 grains of water, and yet the air at 60° remains saturated.

Air at 86° Fah. can only absorb 13.2 grains of water per cubic foot. If, however, only 6.6 grains are present per cubic foot, then 50 per cent of the possible moisture is present and the moisture content can be expressed as 50% saturation, or a relative humidity of 50% the relation being based upon the maximum amount of a cubic foot will hold. Similarly air at 60% Fah. will have a relative humidity of 50% if it holds a half of 5.8 grains of moisture per cubic foot, that is, 2.9 grains. In both these cases the relative humidity is the same. Now supposing the temperature inside a mill is 86° Fah. and it is required to humidify for a certain product to 90% relative humidity, whilst the outside temperature is at 77° Fah. air at 86° Fah. will hold, as maximum 13.2 grains of moisture per cubic foot of air.That quantity represents 100% humidity. For 90% it must contain 11.8 grains per cubic foot. The outside air may contain but 41% humidity, the corresponding amount of moisture content being 4.1 grains per cubic foot. Therefore 11.8–4.1 =7.7 grains which should be introduced per cubic foot of air per hour, assuming that the ventilation allows of the air being renewed every hour.

Effect of Change of Temperature

Cotton and cloth contain in themselves water. If we can imagine cold air, saturated with moisture, entering and remaining in the weaving shed at a temperature of 60° Fah. it could not absorb more moisture and could therefore not interfere with the weaving but if it be warmed by the heating arrangements of the shed there is steam to say 93° Fah. it would at once commence to absorb water from everything in the room which it contains from the bodies of the operatives and from the cloth and warps in the loom. To understand the effect of this change of temperature on the weaving, we must consider what influence water has upon the strength of the threads of cotton where cotton thread is deprived especially of its natural moisture (*i.e.*, about 8%) its strength is very rapidly decreased in proportion. It is very important that the warp threads should not become too dry during the process of weaving. The condition of atmosphere depending upon the position of the shed, greatly influence the weaving and as the air in the weaving shed which is built upon the top of a hill is generally drier than in one situated in a valley near a stream. It is evident that the weaving in the former will be much worse than that in the latter. The threads are weakened by being drier and they would be constantly breaking and as the loom must be stopped for each end to be mended, the result would be that much less cloth could be woven in a given time in a shed where the air is dry than in one where the surroundings keep it moist. If

the weft threads break there is an arrangement provided (weft fork motion) for stopping the loom, but if a warp end breaks, the loom continues to work, and the remedying of this fault lies entirely upon the care and quickness of the weaver who has to attend to two and perhaps more looms. If the weaving is continued after one of the warp threads breaks and unsightly flow is produced in the cloth, which cannot be afterwards remedied. The cloth under these circumstances is therefore reduced in value. The general state of the weather influences the weaving in all sheds. Cold winds are very detrimental to the weaving.

The relatively high temperature of air ranging from about 70° to 80° Fah. according to the character of yarn and the grade or percentage of size, is found from experience to be the most suitable for a sizing room. For strong yarn of course and medium counts and the heavier grades of sizing the lower temperature might be suitable for maintaining that percentage of humidity which is necessary to retain the size on the yarn; but the higher temperature is preferable for delicate yarn of fine counts with pure and lighter grades of sizing.

Air of a high temperature, if not too dry, imparts to the yarn supple and mellow tone or 'feel' without leaving it dry and harsh, and also conduces to a pure and clear atmosphere with a suitable percentage of humidity.

This arises from the fact that air of a higher temperature is capable of absorbing and retaining in suspension, as invisible vapour, a much greater weight of water without increasing the relative degree of atmospheric humidity.

It is necessary for the health of the operators that the air in the weaving shed be kept as nearly as possible about 90° Fah. If the cold air at say 60° Fah. enter the shed it is at once heated to 90° Fah. and as this rise of temperature raises its point of saturation for watery vapour, it commences to absorb moisture from the yarn which is thus rendered brittle. The best weaving is produced when the temperature of the outside air is considerably higher than that of the shed. To avoid the objectionable result in weaving caused by dry air, chloride of magnesium and other deliquescent salts are employed and it is evident that by the use of these substances which hold moisture in the cloth and prevent to a large extent its evaporation, a better and cheaper fabric can be produced. Chloride of magnesium should be used in excess where the atmosphere is damp or full of moisture and this will be found to assist more than using tallow instead of the chloride of magnesium in too great a quantity. Because it (magnesium) is an absorber or attractor of moisture.

Tallow in excess (a small percentage) should be used if the atmosphere is dry and hot as this (atmosphere) will help the tallow to melt and thus assist the yarn to weave better. For ascertaining the percentage of moisture in cotton mills, it is necessary to use 'hygrometer.'

The practice of obtaining humidified atmosphere by 'degging' or the strewing of the floor with water in the absence of efficient humidifying plant, is an excellent one. But it is a practice which is detrimental to the health of the people.

The humidity given to a room should be as homogenous as possible, in its distribution. The water for this purpose should be well filtered and, if possible, disinfected.

Too much temperature, being the result of use of steam, should be avoided. It has been regarded that humidity in a weaving shed of about 75 per cent. for light goods and about 85 per cent. for heavily sized goods suits for normal temperature.

There should be no condensation on the machines or in any part of the room. That is, there should be no dripping from the apparatus used to discharge the moisture, and the latter should be delivered in as fine a state of division as possible. There is only one result which would obtain from the delivery of too coarse a moisture discharge, and that is the settling of moisture on the machines and an unequal humidification of the whole atmosphere. The plant installed should have a sufficient range of moisture discharge to meet the most varied conditions as the outside conditions vary so do the internal atmospheric conditions, so that it should be able to cope with the driest and warmest days by maintaining the hygrometrical condition inside a room in its proper state. The plant should be as nearly automatic in its working as possible. This is necessary from an interval economy point of view, and it should not be necessary that a man should devote the whole of his time in looking after the installation. Further a point, well worth considering, is that automatic safeguards should be present to ensure that there is no possibility of cessation of the air supply whilst the water unautomised is discharged.

Regain for yarns

The regains for the yarns are as follows :—

18 ¼	per cent for worsted.	
17	,,	carded woollen.
18¾	,,	jute.
18	,,	shoddy.
12	,,	flax and hemp.
8½	,,	cotton.

Gain through operation of humidifires=2.5 per cent.

Average cotton regain in finished samples of cloth where humidifiers were not running in cloth room was 5.67 per cent.

Average cotton regain of finished cloth in the mills where humidifiers were running in cloth room was 7.58 per cent.

Difference in Regain due to operation of humidifiers=1.91%

"*Silk.*"—Will absorb as much as 80 per cent of its weight of moisture, depending, of course, on the temperature and atmospheric conditions. The conditioned weight allowed is absolute dry weight plus 11 per cent, and anything over this is adulteration. Silk yarn when bought should carefully and frequently be tested as it can so easily be loaded.

Invisible loss or Regain

"*Cotton.*"—Absorption of moisture by cotton varies according to (*a*) the bulk of the sample, (*b*) the temperature of the air, (*c*) the amount of moisture in the air, (*d*) the length of time the cotton is exposed, (*e*) the barometric pressure. In any case, the absorption of moisture is rapid, and even any yarn will readily absorb 3 per cent of moisture in as many minutes.

In making tests for comparative purposes, the invisible loss or regain may have important effects on the result of the test if the cotton is subjected to varying conditions. In testing for moisture, the cotton should be exposed to a temperature of 212° Fah. for 2 to 3 hours, a sample of one to two pounds requiring only 2 hours. The weighing ought to take place whilst the cotton is in the even; its mere withdrawal from the oven will destroy any pretence at accuracy. A common practice in the mill is to weigh a few pounds of cotton and then place it over a steam pipe or in the boiler house for a few hours. On weighing the dried cotton, an estimate is made as to the amount of moisture it had contained. Such a method, of course, leads to very erroneous results.

Yarn conditioning device

The staples of cotton in its natural or raw condition, tend to repel the size and other solutions. The repeling action is due to the presence of air amongst them. The air must be removed in order to have a more thorough penetration of the size into the body of the threads instead of merely coating upon them. The arrangement of mechanism is done to heat and dry the yarn before it is passed into solution of size and thus causing the threads to expand and become more open and porus. Another arrangement is done to increase the

absorbing power of the yarn by moistening it, previous to the passing of it into the solution of size, for giving moisture to the yarn, a perforated steam-pipe is attached on the sow box opposite to the combined sheet of yarn. Thus the steam is condensed on the yarn and the moisture is attained.

Hygrometers

These are usually composed of the bulb thermometers (one wet and one dry) in which fine thread of mercury is forced along a glass tube by means of the expansion of a small amount of mercury in a bulb, and these are attached to a support. The wet bulb is covered with a small piece of muslin, which is kept moist by the capillary action of a cord dipping into a cistern of water placed underneath. Both thermometers are mounted independently, and the temperatures of air and evaporation are given by the direct readings of both. By comparing those readings with tables provided with the instrument the percentage of humidity is ascertained. It will be obvious that the amount of evaporation will be in proportion to the dryness of the air and that the differences of temperature indicated by the two thermometers will be greater when atmosphere is dry and least when the air is damp.

The following precautions should be observed in the use of hygrometers: (1) The covering of the wet bulb must be very thin; (2) the supply of water must be carefully regulated; (3) The bulb must be constantly moist, yet not too wet; (4) the supply of water must be ample in dry weather; (5) in damp weather water must not drip from the wet bulb; (6) water reservoir must be as far as possible from the dry bulbs; (7) dry bulb must never receive moisture from any source; (8) use distilled rain, or softest water procurable for wet bulb; (9) when lime deposits from the use of hard water, change muslin and cord; (10) replenish reservoir after or long before taking an observation; (11) change muslin twice a month, or according to condition; (12) dust and blacks must not be allowed to accumulate on muslin. The situation is very essential; it should be opened to moist winds but protected from dry ones, and the subsoil should be clay.

In order to produce a condition of the atmosphere most suitable for weaving, a system of artificial moistening of the air or humidification is adopted. Whether air be moist or dry depends not only upon the quantity of moisture it contains, but also upon its temperature. It is not the quantity of moisture contained in the air which determines hygrometric state—it is its capacity or absorbing more. For this purpose there are various types of humidifiers and cooling plants.

The humidifiers are fixed near the ceiling where it is atomised and whence it is diffused by induced currents of air throughout the area of the shed, and this helps to increase production, retain the size and increase the elasticity of the yarn. The humidifiers are also fitted with a patent automatic self cleaning filter and no attention is required to keep the machines working at highest efficiency. These filters are fitted with air vessels that become partly filled with water under pressure when the installation is started. Every time the humidifiers are stopped this store of water is released, and, rushing through the filters washes away any dirt or fibre that may have lodged in them.

Recommended Humidities for Working Conditions

Winding—65 to 70%.
Warping—65 to 70%.
Weaving—70 to 75% Light sized goods.
,, —80 to 85% Heavy sized goods.
Folding Dept—65 to 75%

Heat

Heat is an agent partly natural and partly artificial, which checks decomposition and in some conditions entirely arrests it. It prevents decay by drying as well as by changing the chemical state of substances. At a temperature of 140° most organic bodies are to some extent cooked, and their condition greatly altered, that is, making them less capable of entering into decay.

Thermal Unit

A British Thermal Unit or Heat Unit, is the Amount of heat that will raise 1 lb. of water 1° Fah.

A Calorie is the amount of heat that will raise 1 gram of water 1° C.

A Therm is 1,00,000 B.T.U. It contains heat sufficient to raise 1000 lbs. of water 100° Fah.

Latent Heat

Latent Heat is the number of Heat Units required to change one unit (i.e. 1 lb. or 1 gram) from a solid to a liquid, or from a liquid to a vapour at the same temperature. The latent of Fusion of Ice is 80, of vaporisation of water is 536.2.

MEASUREMENT OF TEMPERATURE

Construction of Themometers

A thermometer is an instrument for measuring in degrees the temperature, that is, the amount of heat present either in the air or in any other body. The most common form consists of a glass tube, sealed and airtight and containing a small amount of mercury, or, as it is commonly known, quicksilver. For its effectiveness the instrument is dependent on the expansion and contraction of mercury under different conditions of heat and cold, thus causing the column of mercury to rise or fall in the glass tube, as the case may be, the reading being obtained by means of a graduated scale that registers the height of the mercury column in degrees. The thermometers used for industrial purposes are generally encased in a metal casing in order to protect the glass.

Types of Themometers

There are three standard thermometers in use, namely, the Fahrenheit, Centrigade and Reaumur. The Fahrenheit thermometer is the one used for ordinary purposes. The Centigrade thermometer, sometimes known as the metric thermometer, is generally used for scientific and experimental work. This thermometer is the simplest, and will no doubt, in time, come into general use.

The Réaumur thermometer is very little used.

Standard Temperature

There are two constant, or standard, temperatures on a thermometer, the freezing and boiling points of water, and the different thermometers vary only in the methods of graduating the degrees of heat or cold. The boiling point of water is indicated on the Fahrenheit thermometers by 212°, on the Centigrade by 100°, and on the Réaumur by 80°. The freezing point of water is indicated on the Fahrenheit system by 32° and on the others by zero. In other words, zero Fahrenheit indicates a lower temperature than zero Centrigrade, while 100 Centigrade indicates a higher temperature than 100° Fahrenheit etc. Fahrenheit readings are indicated by the abbreviation F following the indicated number of degrees, centrigrade by C and Réaumur by R.

Formulae for converting degrees Fah. into degrees C.

(1) To convert degrees Fah. into degrees C.

$$\frac{(\text{Fah.}-32)\times 5}{9} = C$$

(2) To convert degrees C. into degrees Fah.

$$\frac{C\times 9}{5} \times 32 = \text{Fah.}$$

Construction of Hydrometers

For the more convenient determination of the density of liquids instruments called hydrometers are used. The form of hydrometer generally used in mill work is the constant weight hydrometer which consists of a glass tube near the bottom of which are two bulbs. The lower, or bottom bulb is loaded with shot or mercury in order to make the instrument float upright. while the upper bulb contains enclosed air which makes it lighter than water. The point to which hydrometer sinks when placed in pure water at a temperature of 4°C. or 39.2°F. is marked zero and the tube is graduated above and below zero, the graduation being sometimes on a piece of paper placed within the tube.

In taking the twaddle of a liquid it should always be at a temperature of 60°F. Beaume's Hydrometer—For liquids lighter than water :—

The point to which the hydrometer sinks into a solution of 1 part of common salt in 9 parts of water is marked 0°, whilst the one to which it sinks into pure water is marked 10°.

For Liquids Heavier Than Water

The point to which the hydrometer sinks in pure water is marked 0°, and the point to which it sinks in a 10° solution of common salt at (17°C.) is marked 10°. The 'rational scale' of hydrometer is obtained by taking as 0°. the point to which the hydrometer sinks in pure water at 15°C., whilst the point to which it sinks in pure sulphuric acid, of specific gravity 1842 (at 15°C.), is marked 66.

No.	1	Twaddle	0° to	24°	specific	gravity	=1000—1120
,,	2	,,	24° to	48°	,,	,,	=1120—1240
,,	3	,,	48° to	74°	,,	,,	=1240—1370
,,	4	,,	74° to	102°	,,	,,	=1370—1510
,,	5	,,	102° to	138°	,,	,,	=1510—1610
,,	6	,,	138° to	170°	,,	,,	=1690—1850

Nos. 1 & 2—twaddles are used for twaddling the wet wheat flour and the mixed size.

No. 3.—Twaddle is used for twaddling the chloride of magnesium

No. 4.—Twaddle is used for twaddling the chloride of zinc.

Consistency of Size

It may be stated that the strength of the mixing for a certain percentage of size, as indicated by the twaddle, may vary considerably in different mills owing to the difference in the quality of the sizing materials used.

China clay affects the accuracy of the twaddles test more than any other ingredients on account of the variation in the physical character of different clays.

Another practical way of arriving at the consistency of size after it has been prepared is to draw size in a gallon measure (Dia. =7¼" Depth =6⅞) and weigh it. The weight will indicate whether a certain percentage of size to be put on the yarn can be obtained or not. But bear in mind when thus checking size it must be always at a certain temperature, that is, about 160°F.

17 to 18	lbs.	to	1	gallon	will	put on	yarn	about	150 per cent.
15 to 16	,,	,,	1	,,	,,	,,	,,	,,	100 ,, ,,
14 to 15	,,	,,	1	,,	,,	,,	,,	,,	60 to 80 ,, ,,
12 to 12½	,,	,,	1	,,	,,	,,	,,	,,	40 to 50 ,, ,,
10 to 10½	,,	,,	1	,,	,,	,,	,,	,,	20 to 30 ,, ,,
9 to 9½	,,	,,	1	,,	,,	,,	,,	,,	10 to 15 ,, ,,

Specific Gravity

By specific gravity or density is meant the weight of a solid or liquid compared with the weight of an equal volume of water at 4°c. The weight of a liquid as compared with distilled water is known as its specific gravity. These figures may slightly vary due to quality of ingredients etc Distilled water at 60° Fah. is 1, or unity. Liquids heavier than distilled water have a specific gravity greater than unity; lighter liquids, such as gasoline, have a specific gravity less than that of distilled water.

By the metrical system, the weight of one cubic centimetre of the substance in grammes gives at once its specific gravity. The specific gravity of solid bodies may be determined by weighing a piece of the substance, first in the air, and then in distilled water; the

difference in weight will indicate the weight of water displaced, and the specific gravity can be thus calculated. Or, the weight of a known volume of the substance is determined in the specific gravity bottle.

Evaporation and boiling

When water is exposed to the air it evaporates—that is, its particles pass into the surrounding atmosphere in the form of vapour. The rate of evaporation will depend upon the amount of moisture present in the air, the barometric pressure, the velocity of the air, and the temperature.

Measurement of Temperature

Table shewing the Barometric Pressure of Saturated Aqueous Vapour in Millimetres for a given temperature.

Degree C.	Millimetres.
—10	2.09
0	4. 6
+ 5	6.53
10	9.16
15	12.70
20	17.60
25	23.55
30	31.55
35	41.83
40	54.91
45	71.39
50	91.98
55	117.48
60	148.79
65	186.94
70	233.08
75	288.50
80	354.62
85	433.00
90	525.40
95	633.69
100	760.00

Boiling

As will be seen from the foregoing table, the tension of aqueous vapour becomes at 100°c equal to that of the pressure of the atmosphere (at or near the sea level) water is then solid to boil—that is,

if it is exposed to the air at the ordinary barrometric pressure. But if confined in closed vessels (a boiler, for instance) the following relations between pressure and temperature are observed.

Degrees C.	Pressure Atmosphere.
100	1
120.60	2
133.91	3
144.00	4
152.22	5
159.22	6
165.34	7
170.81	8
175.77	9
180.31	10

Dissolved substances materially affect the boiling point of water. The boiling point of water is also affected by the pressure of the atmosphere. The greater the height above the sea-level at which the departments are situated, the lower will be the boiling point of the water.

Hygroscopy for Humidity of Atmosphere

Moisture in the Air—when water evaporates, it is taken up or dissolved by the surrounding atmosphere. The amount of water capable of being thus absorbed varies directly with the pressure and the temperature of the air. When the evaporation has proceeded for a certain time in a closed space the air becomes incapable of absorbing any further quantities of water, and is then said to be saturated.

Effect of Temperature in Yarn Sizing

The temperature at which sizing is done depends upon the material to be sized and type of sizing effect required. In addition to this it may be pointed out that the kind of starches used should also be considered.

It is well known that size may sometimes be washed out of a cloth, and upon examination granules of some of the starches found therein have not even been burst. This may be owing either to an unequal boil, or to bad circulation during the boiling operation, or it may be that the temperature has never been high enough to burst these granules, although the mixture generally may have appeared to be boling.

It is therefore important that the temperature at which the various ingredients in a size mixing will burst, and at which the mixing comes to the boil should be known, otherwise the best results cannot be obtained.

COMPARATIVE HYDROMETRE SCALE

Specific Gravity, Beaume, and Twaddle.

Specific Gravity.	Degrees Beaume.	Degrees Twaddle.	Specific Gravity.	Degrees Beaume.	Degrees Twaddle.
1.000	0	0	1.221	26	44.2
1.007	1	1.4	1.231	27	46.2
1.014	2	2.8	1.242	28	48.4
1.022	3	4.4	1.252	29	50.4
1.029	4	5.8	1.261	30	52.2
1.036	5	7.2	1.275	31	55.0
1.044	6	8.8	1.286	32	57.2
1.052	7	10.4	1.298	33	59.6
1.060	8	12.0	1.309	34	61.8
1.067	9	13.4	1.321	35	64.2
1.075	10	15.0	1.334	36	66.8
1.083	11	16.6	1.346	37	69.2
1.091	12	18.2	1.359	38	71.8
1.100	13	20.0	1.372	39	74.4
1.108	14	21.6	1.384	40	76.8
1.116	15	23.2	1.398	41	79.6
1.125	16	25.0	1.412	42	82.4
1.134	17	26.8	1.426	43	85.2
1.143	18	28.6	1.440	44	88.0
1.152	19	30.4	1.454	45	90.8
1.161	20	32.2	1.470	46	94.0
1.171	21	34.2	1.485	47	97.0
1.180	22	36.0	1.501	48	100.2
1.190	23	38.0	1.516	49	103.2
1.199	24	39.0	1.532	50	106.4
1.210	25	42.0			

To convert degrees twaddle into specific gravity, multiply by 5, add 1,000 and divide by 1,000.

Example.—A liquid stands at 45° twaddle, find its specific gravity.

$$\frac{45^\circ \times 5 = 225 + 1000 = 1225}{1000}$$

Comparison of Thermometer Scale (Centigrade, Reaumur, and Fahrenheit.)

Centigrade.	Réaumur	Fahrenheit.	Centigrade	Réaumur	Fahrenheit	Centigrade	Réaumur	Fahrenheit
0	0.0	32.0	34	27.2	93.2	68	54.4	154.4
1	0.8	33.8	35	28.0	95.0	69	55.2	156.2
2	1.6	35.6	36	28.8	96.8	70	56.0	158.0
3	2.4	37.4	37	29.6	98.6	71	56.8	159.8
4	3.2	39.2	38	30.4	100.4	72	57.6	161.6
5	4.0	41.0	39	31.2	102.2	73	58.4	163.4
6	4.8	42.8	40	32.0	104.0	74	59.2	165.2
7	5.6	44.6	41	32.8	105.8	75	60.0	167.0
8	6.4	46.4	42	33.6	107.6	76	60.8	168.8
9	7.2	48.2	43	34.4	109.4	77	61.6	170.6
10	8.0	50.0	44	35.2	111.2	78	62.4	172.4
11	8.8	51.8	45	36.0	113.0	79	63.2	174.2
12	9.6	53.0	46	36.8	114.8	80	64.0	176.0
13	10.4	55.4	47	37.6	116.6	81	64.8	177.8
14	11.2	57.2	48	38.4	118.4	82	65.6	179.6
15	12.0	59.0	49	39.2	120.2	83	66.4	181.4
16	12.8	60.8	50	40.0	122.0	84	67.2	183.2
17	13.6	62.6	51	40.8	123.8	85	68.0	185.0
18	14.4	64.4	52	41.6	125.6	86	68.8	186.8
19	15.2	66.2	53	42.4	127.4	87	69.6	188.6
20	16.0	68.0	54	43.2	129.2	88	70.4	190.4
21	16.8	69.8	55	44.0	131.0	89	71.2	192.2
22	17.6	71.6	56	44.8	132.8	90	72.0	194.0
23	18.4	73.4	57	45.6	134.6	91	72.8	195.8
24	19.2	75.2	58	46.4	136.4	92	73.6	197.6
25	20.0	77.0	59	47.2	138.2	93	74.4	199.4
26	20.8	78.8	60	48.0	140.0	94	75.2	201.2
27	21.6	80.6	61	48.8	141.8	95	76.0	203.0
28	22.4	82.4	62	49.6	143.6	96	76.8	204.8
29	23.2	84.2	63	50.4	145.4	97	77.6	206.6
30	24.0	86.0	64	51.2	147.2	98	78.4	208.4
31	24.8	87.8	65	52.0	149.0	99	79.2	210.2
32	25.6	89.6	66	52.8	150.8	100	80.0	212.0
33	26.4	91.4	67	53.6	152.6			

When converting :—

Degrees Centigrade. (°C.) into degrees Réaumur (°R.) divide by 5 and multiply by 4.

°C. into °F. divide by 5 multiply by 9, and add 32.

°R. into °C. divide by 4, and multiply by 5.

°R. into °F. divide by 4, multiply by 9, and add 32.

°F. into °R. subtract 32, divide by 9, and multiply by 4.

°F. into °C. subtract 32, divide by 9, and multiply by 5.

CHAPTER XXX.

HINTS ON SIZE MIXING.

The process of sizing textile materials is not a matter of common knowledge, and the ideas of many textile men on the subject are vague. The necessary preparation of warp yarns was, in the past, often carried on behind locked doors—an unnecessary precaution—but to-day there is no secret in the process to the alert and inquiring intelligence.

Size mixing permits of very considerable variation in both the choice of ingredients and the proportions in which they are combined, chiefly according to particular requirements and personal preference, which must not be carried out in a haphazard manner.

No two men ever work under exactly the same natural or artificial conditions. The measure of success of any process is largely determined by conditions. No one can work successfully if he is totally regardless of his environment.

The Liquid Mixture

The size is a liquid mechanical mixture of starches, antiseptics, softeners, and weighting materials, mixed and boiled together in definite proportion to give particular results.

Bear in mind that no two substances can exist side by side and remain unchanged. In some cases changes are rapid and very readily brought about: in others slow.

There is perhaps no operation in the whole range of processes from the raw cotton to the woven cloth, wherein the person in charge is left to his own initiative or skill so much as in the sizing of yarn. He must work to get the "right feel", or handle of cloth, and the right "Sheen" and the "right colour", required for a fine plain, or any other cloth. The "right weight", the "right weaving qualities," along with cover,""fulness and roundness of the thread must also be obtained. His finished sheet must neither be too dry nor too damp. It must open up well at the loom and be free from crossed and lost ends.

He has also to bear in mind the Reed and Pick either to the quarter or full inch and the counts of yarn that he is going to treat or size next and the percentage of size to put on so that the right kind of size is prepared and kept ready in time if not already prepared to avoid loss of production etc.

In laying down a mixing the first thing to ascertain is the amount of weight required to put on the yarn. Then assuming that the sized yarn contains the same amount of mixture as the unsized yarn, then the weight of solid matter put into the mixing, will be the difference in weights between the amount that is left in the sow-box and what rubbed off during weaving must be allowed for.

Supposing, that the weight of yarn without size equals to 980lbs. and the sized yarn equals to 1041 lbs.

$\therefore$ 1041—980 = 61 lbs. weight of size. To this add 5 per cent for waste and rubbing off in weaving which means 61+9 = 70 lbs. of sizing ingredients required in the mixing and then add water equal to the quantity of the ingredients or as required. The amount of the ingredients in the size be added with two cyphers and then divide it by the weight of yarn you will get the percentage of size put on. Sizing is essentially for weaving and a size mixture should be considered mainly from that point of view. Strength alone is not sufficient; protection of yarn during weaving processes, pliability, softness have all to be taken into account. The size has to be protected very carefully from mildew.

These factors are of such a widely different character that it is quite impossible either to dogmatise on the subject of sizing or to give precise data relating to the selection and relative proportions of sizing ingredients to meet specific requirements. But it may be added that the first requisite of the sizing process is the production of a suitable paste, and a knowledge of its inherent properties and its effect in sizing, so that the cost may be brought down as low as possible instead of relying on 'Rule of Thumb.'

By careful adjustment of the quantities of materials used, the cloth, in many cases, can be relieved of that dull, dead appearance which prevents it from looking really first class. A well sized cloth, no matter what percentage of size has been added to the yarn, should have an 'Aliveness' which is lacking in many cloths. Good results can only be obtained by careful observation and perseverance coupled with knowledge and experience.

The use and Blending of Sizing Ingredients

(1) The position and structural features of a sizing room should, therefore, be o' such a character as will conduce both to steam economy and to a warm and relatively dry atmosphere. These objects may be attained successfully by erecting the sizing room in close proximity to the steam boilers, and also by avoiding, as far as practical, undue exposure, within the room, of cold building materials as iron, stone, concrete, cement, etc.

All these materials absorb heat from the a'mosphere, and thereby reduce the temperature of the air in their immediate vicinity to that of the 'dew-point' when condensation begins, and the excess of vapour in the air is deposited as dew on those materials.

(I) If the sizing room is erected as a single story, the floor should be well elevated from the earth to permit of a good current of air in the space beneath it. If, however, the room is in a storeyed building, it should be uppermost to permit of vertical ventilating the trunks passing outside through the roof to expel vapour from the room by means of natural ventilation only, without having recourse to fans. If, however, the room is in a lower story of a building, either vertical trunks of inordinate length would be required to extend outside through the roof or else horizontal trunks would require to pass outside through a sidewall, in which case the vapour could be expelled only by the aid of an extraction fan mounted in the orifice of the trunk to create a draught or air-current.

(2) The floor should be double-boarded with tongued and grooved thick boards of closely grained hard wood, such as teak-wood jara-wood, or similar wood to keep the floor quite dry and warm. Flags, stone pavement, concrete and cement are most unsuitable materials for the floor of a sizing room., as they keep the temperature, low, thereby causing excessive condensation of vapour, and consequently a floor which will always be cold and wet.

(3) The room should be of angular formation, and constructed with one long steep slope for a small room, or else with shorter steep slopes of the saw—tooth or the bay type of roof for larger rooms.

(4) Heating may be affected by means of a steam-pipe of about 2-in. diameter, suspended at an elevation of 7 or 8 ft. from the floor, and extending around the room as well as between two adjacent sizing machines.

(5) A system of ventilating for the supply of fresh air to a sizing room (apart from that for removing the vapour from the drying cylinders and size-boxes) may be effected by means of inlets formed

in the walls, at about the floor level, and by directing the air up vertical ducts that open into the room about 7ft. to 8ft. above the floor, and from which the air is diffused without creating perceptible currents of cold air that would act detrimentally on the yarn.

Foul air may be expelled from the room through outlets formed in the highest parts of the walls or roof, but care should be taken to adopt a form of ventilator for this purpose that will prevent the possibility of reverse currents or down-draughts of cold air passing on to the yarn.

(6) It is indeed very unwise to build low, ill-ventilated sheds, with unprotected corrugated iron roofs, as the increased cost of tallow and magnesium chloride required in a size mixing for such a mill soon negatives any saving made in the construction of the building.

(7) The steam-service pipes should not have a diameter larger than is necessary to supply the volume of steam required for sizing purposes; nor should they, if it can be avoided, pass outside and thus become exposed to cold air, which would induce the condensation of steam. Also, the main-service pipe should be insulated for its entire length by covering it with a good non-conducting material, such as magnesia, silicate cotton (slag-wool), asbestos, cork hair-felting, or other suitable material, of which there are numerous preparations for covering steam boilers, steam pipes, and drying-cylinder ends, with the object of preventing the radiation of heat from them, thereby reducing the condensation of steam.

For only one sizing machine and the usual size mixing plant, a main-service pipe of 2 in. in diameter is recommended with an increase in diameter of $\frac{1}{2}$ in.; 1 in., $1\frac{3}{8}$.; $1\frac{3}{4}$ in., and 2 in., for from two to six machines, respectively; and with branch pipes of not more than 1 in. to $1\frac{1}{4}$ in. to supply steam to the drying cylinders, size-boxes and size mixing becks.

(8) Owing to their excessive elasticity, deficient smoothness, and in part to their lack of strength, cotton and other fibres—especially those of vegetable origin—are either unsuitable for weaving or else would not furnish a fabric of uniform appearance unless previously sized.

There are three methods of applying size to the yarns, *viz.*—

(1) *Hank:*

(2) *Beam to beam (cylinder system):*

(3) *Beam to beam (hot air system).*

Each of these systems has its peculiar advantages and disadvantages. Each has correspondingly its own particular sphere of usefulness.

Sizing varies according to the character of the cloths being manufactured. It may be roughly divided into four styles or kinds, namely, "light", "medium," "heavy" and "extra heavy."

To add, say, 80 to 100 per cent. of weight to the yarn is one thing, but to fix it securely without destroying some of the qualities of the cloth is another. To make the sizing successful, the points which must be taken into consideration are (1) the weight to be added, (2) the class and counts of yarn, (3) the amount of twist in the yarn, (4) the class of cloth to be woven, whether grey, dyed, or bleached, (5) the humidity of the atmosphere, (6) the material to be added in the mixing, and (7) the preparation for and consistency of the materials after being mixed.

In a size-mixture there are the adhesives such as starches, flours, and gums, that penetrate or partly coat the cotton yarn during sizing, the rest of the substances being there merely for coating the yarn to make it heavy and for producing pliability in the yarn so that it may weave well.

Actual practice indicates that yarn in passing through the size takes up approximately its own weight of size. If, therefore, such size contained 10% solid matters (i.e. 1 lb. material in 1 gallon (10 lbs.) of water then the percentage of size put on the yarn would likewise be 10%.

Where ultimate finish of cloth is of importance, as in calendered goods, additional substances are put in the size to suit the finish.

The Penetrating Power of the Starch

The penetration of starch into the yarn depends on (1) viscosity of the starch paste; (2) the construction of the yarn, e.g., turns per inch, etc. (3) squeezing; (4) prolonged pressure; (5) temperature; (6) speed of the sizing machine; and (7) concentration of the paste. The strength of yarn is determined by the amount of size penetrating into the yarn. The lower the viscosity and the higher the degree of dispersion of starch in the size, the greater the penetration into the yarn. " The penetrating power of the starch is considered as the extent to which the starch paste has penetrated into the yarn or fabric and the completeness with which it has filled in the spaces between fibres."

By coating is meant that the starch merely adheres to the outer portion of the yarn and surrounds it like a casing which eventually might fall out on account of friction of healds and reed.

Starches form the general body, gum solidifies it and dextrime, being soluble, penetrates the yarn. The degree of penetration remains however a matter of conjecture, and is dependent on fluidity of the size, the softness of yarn and surface resistance of the mixture.

Sized warp must be very clean, fairly smooth and sufficiently stiff, in order that the material may not be roughened or worn through in the scouring process. Further more the threads in the woven fabric must exhibit sufficient fulness, agreeable feel, absence of smell, and in the case of coloured goods, purity of colour to satisfy the weaver and buyer. Unfortunately it is not always possible for the sizer to meet these requirements in their entirely, since, as in other matters, the question of cheapness is important owing to the keen competition, and must always be borne in mind. It is, however, a bad policy to spare expense in small points of this important intermediate treatment, such false economy often resulting in spoiling the appearance of the goods. A slight additional outlay often saves the manufacturer considerable expense in labour, giving a better and more saleable article, thus recouping the small extra cost.

(9) Owing to scientific research many materials that were formerly used in sizing are now entirely discarded, not merely as being of unsuitable character, but as harmful, especially in view of the operation of certain chemical reactions that were liable to develop under unfavourable climatic and atmospheric influences, as exposure to moisture and heat, and also to the intense heat of calender rollers during the finishing operation.

In addition to the better knowledge of the physical and chemical properties of the various sizing ingredients, the different types and varieties of fabrics that are now produced are of such a character of texture and finish that anything in the sizing of the warps that is not absolutely necessary to ensure perfect weaving is quite superfluous, for the simple reason that most fabrics now-a-days owe their characteristic 'feel,' 'handle,' and 'texture' to the particular style of 'finish' which depends not so much on the grade or method of sizing (as in many of the former types of fabrics), but on the particular method of finishing those fabrics.

The conditions and practices of the modern cotton industry, in particular—efficiency in the sizing department—were never of greater importance than they are to-day, and this for the simple reason that many warps are produced from yarn of finer counts, are woven in finer reeds, and usually with a relatively greater number of warp threads per inch. Hence it is not too much to assert that the sizing department of the modern cotton weaving mill is of greater importance than that of any other, not excepting the winding and warping departments. Nor does the remark apply only to the actual operation of sizing the warps which, after all, is a mechanical operation of which the successful performance is chiefly dependent on the efficiency of the sizing machine and its equipment with suitable accessories adapted to control the various functions incidental to sizing automatically; and in a lesser degree, also to the manual dexterity and skill of the attendant whose chief duty is to see that the sizing plant is functioning properly.

(9) A large number of ends take up size more rapidly than a small number.

(10) Hard twisted yarn requires a thin size, with plenty of softeners in the mixing, but not too much of it.

Soft twisted yarn requires a thicker size, also a greater weight can be put on the threads.

The formation of warper's bobbins during winding in order to retain the elasticity of the yarn should be on the soft side and not wound hard. Softly wound warper's bobbins will also help to increase the production in the warping as well as in the weaving.

(11) The length of yarn on the weaver's beam and the number of picks per inch will influence the length of time a beam remains in the shed. Beams that are to remain in the loom for a long time may become soft if starch, particularly farina, is the basis of the sizing.

But farina, if prepared in a proper manner, will not lose its sized value. Farina gives a soft feel to the cloth and good resistance to the rubbing action with which the yarn has to contend in its passage through the loom.

(12) There is always the danger of mildew in a damp shed, or if the godowns where the cloth bales are stocked are too damp.

Also bear in mind if excessive tallow or chloride of magnesium is used in a mixing, there will positively be a risk of encouraging mildew unless sufficiently protected by antiseptics.

The heavier the size required, the more solid matter it must contain, and the more solid matter present, the greater the amount of adhesive required. The presence of excess of moisture, due to excess of a deliquescent ingredient, brings about decomposition or mildew.

(13) The number of ends and the ends per dent will determine the amount of chafing in the healds and reeds used

(14) Fine reeds put extra friction on the threads and require careful sizing to prevent dusting at the loom.

(15) The counts of yarn as well as the weave control the amount of chafing that the threads are subjected to during shedding. The greater the number of shafts in the case of a dobby loom the greater will be the amount of chafing.

(16) The temperature and humidity of the weaving shed have an influence on the use of softeners and antiseptics.

The temperature at which sizing is done depends upon the material to be sized and type of sizing effect required. In addition to this it may be pointed out that the kind of starches used should also be considered for the purpose of keeping the temperature sufficiently high to burst the granules of the various ingredients used in a size-mixing and at which the mixing comes to the boil should be known, otherwise the best results cannot be obtained.

The condensation of steam will be relatively greater when sizing warps are composed of coarser counts of yarn, or containing a greater number of warp threads, and also with the heavier grades of sizing, because of the longer period of time or greater heat required for drying the yarn. Under these circumstances, therefore, either the speed of the machine is reduced, or else the steam pressure in the cylinders is increased in order to augment their drying efficiency according to requirements.

(17) In sizing coloured yarns it must be remembered that colours are adversely affected by certain materials such as china clay, chlorides, etc.

A dyed warp has to have a transparent size so as not to dull the colour hence the potato starch and some gums having transparency should only be used.

It may be added here that some of the sizing or weaving masters have the practice to add a mixture of melted rosin, tallow, etc., to the size, especially when heavy loading is in question, whilst these

substances, which fix the size to the thread on solidifying in the cold, enable a larger amount of material to be brought on to the yarn, their use is nevertheless to be deprecated when the woven fabric is to be put through any subsequent treatment, such as 'finishing', 'bleaching,' or 'dyeing' as they may give rise to defects, such as patchiness, smears etc,

(18) Other considerations are, the character of the finished texture, as regards its weight, tone, and feel, the character of the finishing operation, if any, to which the cloth will be submitted after weaving, as bleaching, dyeing, printing, calendering and singeing, the use of the fabric, also its ultimate destination as regards transport by land and sea, and climatic conditions of the country in respect of temperature and humidity, hard or soft water supply, position of shed, dry or damp, whether humidity is used or not.

Cloths manufactured for a hot humid climate require waxes with a high melting point as softeners in place of tallow. Chlorides should never be used for cloth intended for bleaching and dyeing, as in the singeing process the chlorides would tender and weaken the cloth.

In monsoon deliquiscent substances and softeners are much reduced in size mixings, while in summer they are greatly increased so that the yarn becomes pliable and elastic.

(19) When preparing a size-mixture, solid substances (flour or starch) should be weighed, as, weighing alone will ensure the correct amount of starch in the mixture. Liquids should be measured very carefully and they should also be of uniform strength as regards the relative density or degrees by Twaddle's hydrometer, otherwise, any variation in this direction, especially of caustic alkali and chloride solutions, will require to be properly adjusted by varying the amount of those liquids accordingly. Softeners and compounds should be accurately weighed and added to the mixture in the tank when slightly warm, but before the boiling point has been reached.

(20) Uniform results are obtainable from size paste, prepared in accordance with a given recipe, only by employing ingredients of uniform quality and relative density, by combining them in the same relative proportion and order, by heating them at the same temperature, and for a corresponding period, and also by applying to the yarn the size-mixture at the same temperature and density. Excessive water in the sow-box thins down the size and thus soft warps follow.

Too much condensed steam should be prevented from finding its way into size box either by having the sizing room near the boiler or by the use of steam traps.

The efficiency in the sizing department does depends not only upon the selection of the most suitable ingredients and their proper blending, mixing, and cooking, but also on the means which are of the greatest importance of applying the size to the yarn under the most favourable conditions as regards both the temperature and viscosity.

Hence, in order to ensure the highest degree of efficiency in every respect consistent with production costs, it is essential that a modern sizing room plant should comprise mechanical details and appurtenances incidental to the preparing and supplying of size.

(21) The stirring of the starch and water in the case of light size should be in operation at least one hour before the tank is filled to capacity and then the steam turned on—a little longer stirring will do no harm.

In case of medium or heavy size all ingredients should be introduced in the finishing beck and allowed to be stirred and mixed well at least for two hours before the steam is turned on.

(22) The officer-in-charge of the size-mixing is well advised to keep his size-mixture as simple as possible and use only those substances the composition of which is known to him. At the same time bear in mind,, whenever determining the value of a substance to be used for sizing, the following points :—

(1) Low price; (2) there should be no detrimental properties as regards its action on the weaving; (3) there should be no injurious impurities or latent defects which would cause damage to the cloth after it is woven.

(23) The ingredients meant for size-mixing ought to be tested or analysed every time a fresh purchase is made.

(24) Pure sizing requires only sufficient to get it through the loom, as all the size must be removed after weaving, if intended for bleaching, dyeing, or printing.

Sago should be well boiled in the size beck before running into the frame sow-box, but farina should be heated only just sufficiently to gelatinize some of the starch, and the boiling completed in the sow-box.

The use of glycerine in the pure size, in spite of its high price, should be greatly encouraged. It strengthens the yarn and makes weaving easy. However it should be borne in mind that if glycerine is used, salicylic acid should necessarily be used as an antiseptic, otherwise the bygroscopic character of glycerine will be a suitable medium for the growth of mildew.

(25) Medium sizing is used in the manufacture of good and light classes of cloth such as good shirtings, jaconets, mulls and coloured bordered *Dhoties* or *Sarees*. The percentage of size put upon the warp in these cases is from 25% to 50%.

Heavy Size

In case of heavy sizing, the weight put into the warp is from 50 to 100 per cent. It is used in heavy, coarse fabrics to give bulk and weight at little cost. Many of these goods are used for common linings. Khaddars, which are used in several parts of India, are exchanged weight for weight of cotton plus the weaving charges (about 4 annas per lb.) in cash in certain parts of India. The heavy sized or finished or back filled cloths (such as Mexicans) are used for burial purposes in Persia and other eastern countries.

Extra Heavy Size

A few years ago, 50 or 60 per cent was considered heavy sizing; to-day you can meet with 100 or 200 per cent; and, as the years go on, the percentage of size in some cotton goods seems to go higher.

Starch, clay and metallic salts relate to percentages, and the finish. A particular percentage may be obtained by varying the proportion of clay and metallic salts.

(26) Basis of Pure Size.

To prepare a mixture say for a 10 per cent size proceed as follows.

Size of Beck	$=4' \times 4' \times 4'$.
Gallons to one inch	$=8.33$ approximately.
Size per cent	$=10$
Counts of yarn	$=30$s Twist.
Counts of Reed	$=40$

Proportion of Starch to water $=1$ to 10.
Level of Size in the finishing Beck $=41''$.

∴41 × 8.33 = 341.53 Gallons. 341.53 × 10 = 3415 lb. practically.

Starch	= 342 lbs.	(1 part starch to 10 parts of water)
Tallow	= 34 ,,	(10% on weight of Starch)
C. Soda	= 2 less,,	(.50 on weight of Starch app.)
	378	
Water	= 304 Gallons.	(as shown below)

3415 lbs of water.
378 ,, Weight of Ingredients.

3037 ÷ 10 = 304 practically Gallons of water.

The quantities of starches and softener need adjustment for local conditions such as summer and winter and also the counts of reed. Less softener is required during the winter months and more during the summer months.

The finer the reed the stronger the size is required to be made. For 56 Reed the proportion of starch should be one pound of starch to one gallon of water.

For every end and pick per ¼ inch above 14 increase the starch one ounce per gallon of water and the softener ½ ounce for every nine pounds.

Softener = 5 to 10 per cent on the weight of solids or half to one pound of softener to every nine pounds of starch.

C. Soda = .40 to .50 on the weight of solids.

ch. of Zinc = 3 to 5 per cent on the weight of Solids.

ch. of Magnesium = 12 to 15 per cent on the weight of Solids.

Chlorides of Zinc and Magnesium are taken in the solid form..

1 Gallon of ch. of Magnesium at 58° Tw. = 12.90 lbs.

1 Gallon of ch. of Zinc at 102° Tw. = 15.10 lbs.

Magnesium ch.—Not less than 11½ Gallons at 58° Tw. per sack of 280 lbs. of Flour.

Zinc ch.—Not less than 3½ Gallons at 102° Tw. per sack of 280 lbs. of Flour.

Change of circumstances, such as humidity etc may demand an increase or reduction of chlorides in a size mixing.

When chlorides are part of a mixing, caustic soda must not be used.

Clay = If clay is to be introduced in a light size mixing then take 40 lbs. of clay to every 100 lbs. of starch.

Mode of Preparation of Light Size.

(1) Admit 20″ of water in the finishing beck bring to boiling point. Add caustic Soda if part of the mixing or the chlorides.

(2) Mix the starches in a separate pan placed above the finishing beck with 18″ of water and tallow.

(3) Empty the emulsion into the finishing beck.

(4) Add Aktivin S.

(5) Stop Steam after seeing that the tallow, oil, or wax; if part of the mixing, is well mixed in the preparation.

(6) The time taken in reaching the boiling point depends upon the dryness and pressure of the steam. When the bubbles of steam pass freely through the mass and reach the surface the boiling point has been attained. At this point the time should be noted and the boiling continued for at least two hours before using the mixture. When the boiling point is reached the steam valve should be throttled to a point where the boiling is maintained and yet the contents not forced out of the tank. What actually counts in the sizing operation is the volume of the finished size. Due regards should be given to this measurement; if for any reason steam should be abnormally wet or the water valve leaking, the final concentration will be unfavourable in spite of all accuracy used in measuring and weighing. For every formula there is a certain percentage increase of volume, calculated upon the original volume of water used due to the condensation of the steam, the expansion of starch and the expansion caused by the elevation of the temperature. Should this increase show abnormality, the cause should be investigated.

It is always best to twaddle the mixture before and after boiling and a record kept of the results obtained of the percentages, feel appearance, whiteness, etc.

A method sometimes adopted is to use an insufficient quantity of water at the start and just before the boiling is completed sufficient water is added to make the required volume. The boiling, of course, must be continued during the addition of the water so that the mixture is boiling when the full quantity is reached. This must be done with great care. Inattention would spoil the whole mixture.

It is advisable to have steam traps wherever necessary to eliminate as much as possible condensed water finding its way either in the size vats or sow-box.

After the mixture has been boiled for at least two hours it should be kept ho' (by means of a steam-jacket or a closed steam coil) before being run into the sow-box.

EXAMPLE :—

If a pure mixing for 56 reeds and 56 picks to the inch is as follows :—

What will be the mixing for 60 reeds and 60 picks to the inch ?

Farina or both combined	=287 lbs.
Tallow	= 32 ,,
Water	=287 gallons.

Ans: The mixing for 60 reed and 60 picks will be as follows :—

Water =287 Gallons.

Starches =(60 × 60) — (56 × 56) = eight ounces per gallon of water extra = 430 lbs.

Softener =eight half ounces extra for every nine pounds of starch on the weight given above for 56 × 56 = 44 lbs.

The above rule for arriving at a proportion of a mixing on the basis of reed and pick will only stand good up to 80 reed and 80 pick to the inch.

The above rule (with regard to proportions) is sufficiently safe to be used as a basis, but careful observation will be needed to adjust to various reeds and picks, and to local conditions, which vary nearly in every mill.

It will be evident to any sizing master that the mixing for 80 reed and 80 picks will be found fairly satisfactory for the higher reeds and picks if a little extra softener is added, along with one lb. of best soft soap in order to present the size yarn from sticking to the drying cylinders.

(27) Basis for Medium Size.

Solids—10 parts of flour or starches to 7 parts of clay for a 50% size. For above 50% the proportion will vary according to the percentage of size and class of goods.

If yarn be sized with a mixing prepared with 50 percent of Flour or starch and 50% China clay will weave very satisfactorily, but the body of the cloth will not be as good as the body of the cloth sized with 10 parts of flour or starch and 7 parts china clay.

Example ;—

40 to 50% Size Mixing.

Size of beck 8′ × 4′ × 4′ (gallons to one inch) =16.66
Contents of beck in a level with agitator =40 inches.
Water in flour beck (8′-4″ × 4′ × 4′) to one inch = 17.36 gallons

1 part of flour to 2 parts of water. }
or, 1 ,, ,, ,, 1 ,, ,, } Proportion of water to flour

Details of Preparation.

Finishing Beck—After admitting flour and the clay, if necessary, add water to bring to the level of the agitator.

Solids = 40″ × 23 pounds to one inch = 920 pounds for a beck 4′ × 4′ × 4′ and 1840 pounds for a beck 8′ × 4′ × 4′ both flour and clay.

The proportion of flour and clay for a beck of 4′ × 4′ × 4′ would be flour = 540 and clay = 380 lbs. or 500 pounds of flour and 420 pounds of clay.

In the case of a beck 8′ × 4′ × 4′ would be flour = 1080 pounds, clay = 760 pounds or 1000 pounds flour and 840 pounds clay.

It may be added here that the above proportions are given as an example. The proportions will vary as it may be required.

Chloride of zinc = 8 to 12% on the weight of flour and starches, will be enough, provided the beams are not run too damp.

Chloride of magnesium = 20 to 30% on the weight of flour or starches.

Softeners = 18 to 25% on the weight of flour or starches. An excessive amount of tallow has a tendency to make the size pliable but has the effect of causing the size to rub off in the healds and reeds and promote mildew as well.

Mode of Preparation I.—50% Mixing.

(1) Admit the required quantity of flour and water into the finishing beck. Flour whether steeped or fermented should contain the required quantity of chloride of zinc and Magnesium.

(2) Get the clay pan containing, clay and tallow, ready well boiled. Add chloride of Magnesium.

(3) Boil the flour to 100° Fah.

(4) Empty the contents of the clay pan.

(5) Add Aktivin S.

(6) Boil to 180° Fah. and then stop the steam.

(7) The size when ready should weigh 12 to 12½ lbs. to 1 gallon.

(8) The mixture should twaddle 18°, that is, when flour and clay and the other ingredients mixed together in the finishing beck with the required quantity of water before the steam is put on.

Mode of Preparation II.—50% Mixing.

(*i*) Admit flour containing chloride of zinc in the finishing beck.

(*ii*) Take the necessary quantity of water.

(*iii*) Boil clay and tallow for about four hours. Add chloride of magnesium.

(*iv*) Let the contents of the clay pan cool down.

(*v*) Empty the contents of the clay pan to mix with the flour into the finishing beck. Let it stand and agitate well at least for half a day. Then boil as required.

In mixing china clay, let the proportions of clay to water be 1 lb. of the former to ½ lb. of the latter with just sufficient tallow or oil to prevent the tendency to spurting.

Care should be exercised with regard to sudden rising of clay when boiling, while introducing washing soda for the purpose of breaking up the china clay.

I. Mode of Preparation—100 per cent mixing.

(1) Admit clay in the clay pan containing 12″ water. Size of pan =3′—6″ × 3′—6″ × 3′—7″

(2) Add maize starch, Epsom Salt (if part of the mixing) part of wax, tallow or oil and chloride of magnesium into the clay pan.

(3) Boil for about 4 hours.

(4) Take in the finishing vat the final quantity of water if necessary and then add the full mark or the required quantity of flour per mixing and the remaining portion of tallow, oil or wax.

(5) Boil the content of the finishing vat until it thickens and when it just begins to thin down then let down the content of the clay pan after doing so boil for a short time the whole content of the finishing vat until everything gets mixed up to a required consistency.

(6) Add Blue and after a short while use it up. The blue can be added to the flour in the course of steeping.

II. Mode of Preparation—100 per cent size.

(1) Boil clay for four hours together with tallow, wax and oil.

(2) Take your flour in the finishing beck and add the make up water if necessary.

(3) Mix the content of the clay pan with the content of the finishing vat after cooling down the clay.

(4) Let the whole content of the finishing vat agitate together.

(5) Draw from the finishing vat a portion at a time and boil in another vat and use it up, continue doing so in portions until the whole content is used up. This method of preparing size avoids jamming up of the agitators and wastage, as you can prepare as much as you like and as often as you like.

(28) Mixing becks should only be filled to the top of the dashers, and if filled above them there is a risk of loss due to overflowing, also the mixing above the dashers will receive a circular motion, and will not be completely agitated and broken up.

Size should be kept boiling, but violent agitation should be avoided.

When the ingredients have been mixed the speed of the agitators may be considerably reduced, and just sufficient movement given to keep the size on the move

$$\left.\begin{array}{ll}\text{Starting speed of the agitator} & =36 \\ \text{Reduced ,, ,, ,, ,,} & =18\end{array}\right\}\text{ Very important.}$$

Control of the temperature of size during mixing should be carefully regulated and as short a time of preparation as possible should be adopted. If the time of the heating of the size does not exceed six hours, no important deterioration will be produced.

(29) In order to secure uniform results, the conditions in the sow-box must be kept as constant as possible. There are two variable factors which should be controlled with care.

(*a*) The level of the size must be kept constant. A variation in the level means a variation of the time during which the yarn is in contact with the size. The result is lack of uniformity. If the level is controlled by the intermittent opening and closing of a valve by the operator, the chances of irregularity are great on account of the personal factor involved. The introduction of a constant level device, preferably of the overflow type in connection with a circulating system, will solve the question with entire satisfaction.

(*b*) The temperature of the size in the sow-box must be kept constant. The viscosity or fluidity of any size mixture will vary with the temperature. The facility with which a size mixture is absorbed by the yarn will vary with the viscosity of the paste. It is therefore clear that for a uniform absorption, which means a uniform dressing, a constant temperature should be maintained. Having determined for any given formula and type of work the most favourable temperature which may be at the boiling point or slightly below, it should be maintained as nearly constant as possible. Here again the personal factor is uncertain and may be entirely eliminated by the use of a temperature controller.

A steam jacketed sow-box is preferable as this ensures the starch being kept hot until consumed, or alternatively a ½" steam pipe running through the sow-box will ensure that the mixture is kept at the correct temperature (190° Fah.) This ½" copper pipe may be led from the main steam pipe which feels the drying cylinders.

Steam pipe in the sow-box should periodically be examined and changed if the holes are enlarged.

Also the size-box should be thoroughly cleaned fortnightly.

(3) Successful sizing requires not only a thorough penetration and saturation of the yarn, but also thorough and rapid drying without scorching, the proper distribution of the yarn and the making of a hard, uniform compact beam. The value of the size lies in the srengthening, lubricating and softening of the yarn so as to render it strong, smooth and pliable.

Percentage of Moisture.

The percentage of moisture left in the yarn after sizing is of very great importance. Too little will cause brittle yarn, which means bad weaving, whilst too much may result in mildew trouble, or if not that, in the loosening of the size on the yarn, causing serious trouble at the healds and the reed. Consequently the production will be poor or less and the proportion of the damaged or rejected will be larger.

The "Percentage of Size and Percentage of Moisture."

The following table shows the weight or percentage of size and a reasonable percentage of moisture which may be left in the sized yarn.

Kind of Size.	Percentage of Size	Moisture content.
Pure Sizing	upto 12%	5 to 8%
Light ,,	13 to 25%	8 to 10%
Medium ,,	25 to 75%	10 to 13%
Heavy ,,	over 75%	13 to 16%

Secret (of Best Results) of Preparing Size.

The secret of preparing of size lies in the boiling. Every granule of the starch must be open or else the full sizing value is not secured. The size must be cooked so that its full adhesive value is brought out, so as to adhere to the yarn by cementing the filaments of the fibre together so well, that they may withstand the chafing action of the healds, etc., and not rub off during weaving and the subsequent processes.

STIFFENING TEMPERATURE.

Wheaten flour	= 180° Fah.
,, starch	= 180° ,,
Maize flour	= 167° ,,
,, starch	= 167° ,,
Rice flour	= 170° ,,
,, starch	= 170° ,,
Farina	= 149° ,,
Sago flour	= 158° ,,

Temperature at which Best Sizing Results are Obtained.

The most efficient sizing can be attained only when the temperatures of the size are controlled between definite limits.

When the temperature of the size is low the warps will be very harsh and rough, resulting in excessive droppage in the looms, due to the fact of insufficient penetration of the starch which remains coated on the outside of the yarn, thus producing a harsh, brittle yarn.

When the temperature is very high, the size will be thin, due to condensation, and consequently the size will be squeezed out of the

warps by the top pressing roller of the sizing machine, with the result that the warp will be so lightly sized that there will be an excessive amount of breakages in the looms, and thus owing to there being not enough starch remaining in the yarn, the warp becomes soft.

As the amount of weight added to the warp and the increase in breaking strength are the best indications of the efficiency of a size mixing, and to obtain the former result, namely highest percentage of weight the temperature must be maintained between 180° Fah. and 190° Fah., also to obtain the better result, namely the greatest increase in the breaking strength of sized over unsized yarn, the temperature must be maintained between 180° F. and 190° F.

At a temperature below 180° F. the warps will be harsh and will not weave well on account of excessive droppage, while at a temperature above 200° F. the warps will be soft. There is a great advantage in maintaining the temperature of the size uniformity at 190° F.

Particulars of Size Mixing Becks—Square Flour Beck.

Size of driving drum	=	12″
Revolution of line shaft	=	92 R.P.M.
Size of driven pulley	=	12″
Bevel wheels driver	=	19 T, driven = 46 T.
Revolutions of dashers	=	38 starting, reduced to 19 when flour is mixed.

Cubical contents = L × B × D = 8′—3″ × 4′ × 4′ = 132 cubic feet.
132 × 6.25 (galls. to 1.c.ft.) = 825 galls.
825 ÷ 48″ (depth) = 17.18 galls. to one inch.

Rules;—

Area = Length × Breadth.
Length = Area ÷ Breadth.
Breadth = Area ÷ Length.
Cubical Contents = Length × Breadth × Height.

To Find ;—

$$\text{Length} = \frac{\text{Cubical contents}}{\text{Breadth} \times \text{Height.}}$$

$$\text{Breadth} = \frac{\text{Cubical contents}}{\text{Length} \times \text{Height}}$$

$$\text{Height} = \frac{\text{Cubical contents.}}{\text{Length} \times \text{Breadth.}}$$

Circular Finishing Beck.

Size of driving drum	= 12″
Revolution of line shaft	= 92 R.P.M.
Size of driven pulley	= 12″
Bevel wheels (driver)	= 18 T. (driven) = 46 T.
Speed of dashers	= 36 starting, reduced to 18 when size is cooked.

Particulars of Size Mixing Becks.

Circular Finishing Becks.

Size of Becks = 4′—8″ Dia. × 3′—11″ Depth.

Top Breadth = 4′—8″, Bottom Breadth = 4′—0″, Depth = 3′—11″

$(TB^2 \times BB^2) \div 2 = x$

X × .7854 × Depth = cubical contents.

$$\frac{196}{9} + 16 = \frac{340}{9} \div 2 = 18.88 \text{ ft.}$$

$18.88 \times .7854 = 14.8283$ ft.

$$14.8283 \times \frac{47}{12} = 58.0678$$

$58.0678 \times 6.25 = 363$ Galls.

$363 \div 47 = 7.72$ Galls. to one inch.

Circular Clay Pan.

Size of driving drum	= 12″
Line shaft speed	= 92 R.P.M.
Size of driven pulley	= 12″
Bevel wheels, (driver)	= 20, Driven = 46
Speed of dasher	= 40

Top Breadth = 8′–6″, Bottom Breadth = 8′—6″, Depth—3′–7″

Diameter, × .7854 × Depth = C. contents.

42″ × 42″ = 1764, 1764 × .7854 = 1385.456.

1385.456 × 43 = 59574.1608.

59574.1608 ÷ 276.48 (Galls. to 1 C. inch) = 215.48 Gallons.

215.48 ÷ 43 (Depth) = 5 Galls. to one inch.

Circular Clay Pan.

Size of Beck.	Cubical Contents.	Galls. per Inch.
Dia. =32″ ×32″ Depth	=105.6 Galls.	=3.3 Galls.

Details of Pipes.

Pipes for flour becks	=	$2\frac{1}{2}$″ to 3″
Size of feeding pipes	=	2″
Steam pipes	=	$\frac{3}{4}$″ to 1″
Water ,,	=	$1\frac{1}{4}$″ to 2″

Size of Pump.

Diameter	=	$3\frac{1}{2}$″
Stroke	=	5″
Suction	=	2″
Delivery	=	2″

Pressure of Steam Supply.

The steam supply for cooking should be at a pressure of 25 to 30 pounds per sq. inch.

Economy in Mixing Size.

The greatest economy should be exercised in size mixing, but this should be combined with discretion. The quality and quantity of the ingredients used in the size cannot be reduced without impairing the feel and the finish of the cloth, but certain alternative substances may be used that will give the same results, as far as percentage of size is concerned, and will reduce waste without doing any harm. For example, sago does not fall away as soon as maize starch and farina, and if the latter has been in constant use a mixture of Sago and maize starch or farina may be tried. For very light Sizing sago alone could be used in place of farina. Many firms use patented softeners, soluble starches etc. which need a great deal of knowledge for selecting such ingredients if economy is really the main object.

Cubical Contents of Various Sizes of Becks.

Size of Beck.	Cubical Contents.	Galls. per Inch.
9′-4″ × 8′-4″ × 8′-4″	4046 Galls.	40.46 Galls.
8′ × 4′ × 6′	1200 ,,	16.66 ,,
8′ × 4′ × 5′	1000 ,,	16.66 ,,
8′ × 4′ × 4′-8″	932 ,,	16.53 ,,
8′ × 4′ × 4′	800 ,,	16.66 ,,
8′ × 4′ × 3′	600 ,,	16.66 ,,
8′ × 2½′ × 2¼′	281 ,,	10.41 ,,
6′ × 4′-6″ × 4′-8″	731 ,,	13.05 ,,
6′ × 4′ × 4′	600 ,,	12.50 ,,
5′-6″ × 3′-6″ × 4′	481 ,,	10.02 ,,
5′-3″ × 3′ × 3′	295 ,,	8.18 ,
5′ × 5′ × 5′	781 ,,	13.02 ,,
5′ × 4′-6″ × 3′	422 ,,	11.72 ,,
4′-8″ × 4′-2″ × 4′-2″	505 ,,	10.00 ,,
4′-2″ × 4′2″ × 4′-8″	505 ,,	9.02 ,,
4′ × 4′ × 5′	500 ,,	8.33 ,,
4′ × 4′ × 4′	400 ,,	8.33 ,,
4′ × 2′ × 2′	100 ,,	4.16 ,,
3′-10″ × 3′-10″ × 4′	367 ,,	7.63 ,,
3′-6″ × 3′-6″ × 4′	306 ,,	6.37 ,,
3′ × 3′ × 4′	225 ,,	4.68 ,,
2′-10½″ × 2′-10½″ × 2′-10½″	148 ,,	4.29 ,,
2′-6″ × 2′-6″ × 3′	117 ,,	3.25 ,,
2′ × 2′ × 2′	50 ,,	2.08 ,,

Adhesive, Agglutinating and Strengthening Materials :—

Wheaten Flour.
Wheaten Starch.
Maize Starch.
Rice Starch.
Rice Flour.
Sago (Pearl and Flour)
Farina.
Servolin.
Sacoline.
Penetrose.
Dextrine.
Irish Moss.
Size Trose.
Agmol.

Softening and Opening Materials :—

Tallow.
Glycerin.
Cocoanut oil.
Olive Oil.
Palm oil.
Pine oil.
Castor oil.
Stearine.
Soap.
Japan Wax.
Paraffin Wax.
Spermaceti.
Cotton Seed oil.
Glucose.
Soluble oil.
Turkey Red or Alizarine or Olive oil.
Size Win-A.

Materials for giving Weight and Body.

China Clay.
Sulphate of Magnesium (Epsom Salts).
Sulphate of Calcium (Sulphate of Lime or Gypsum).
Sulphate of Soda (Glauber's salts).
Sulphate of Barium (Barytes)

Deliquescent Substances.

Chloride of Magnesium.
Chloride of Calcuim.
Glycerin.

Antiseptics.

Chloride of Zinc.
Sulphate of Zinc.
Carbolic Acid.
Cresylic Acid.
Salicylic Acid.
Glycerin.
Thymol.
Borax.
Formic Acid.
Creosote.

Materials to give whiteness.

Oxamine Blue B. B.
Alizarine Saphirol B.
Blankit H or Rongalite c
Formy Violet.
Indenthrine Blue R.R.N.P.
Indenthrine R.S.G.M.
Indenthrine Blue R.Z.
Indigo Blue.
Ultramarine Blue.
Prussian Blue.
Blue R. R.
Dianine Blue R.W.
Methaline Blue 3 R.
Tetracyanol Blue.
Solway Blue B.N.S.

SHIRLAN & SHIRLAN NA-MILDEW ANTISEPTICS.

Shirlan and Shirlan NA are very powerful mildew antiseptics being approximately 30 times more powerful in action than Zinc Chloride. The use of these products as mildew antiseptics in sizing was discovered and patented by the British Cotton Industries Research Association of Didsbury, Manchester.

Shirlan is marketed in two forms, as Shirlan Powder and Shirlan Paste. Shirlan Powder being twice as strong as Shirlan Paste. To render cotton immune from mildew attack, applicatian of 0.06% Shirlan Paste or 0.03% Shirlan Powder calculated on the weight of material after sizing should be sufficient i.e. 1 oz. Shirlan Paste or ½ oz. Shirlan Powder per 100 lbs. of sized cotton. In use, the correct amount of Shirlan is added to the cold mixture of starch and water before boiling up.

It should be noted that Shirlan unlike Zinc Chloride, has no tendering action at all on cotton cloth, is non toxic to the human system and quite stable to atmospheric action.

In addition to its use for the prevention of mildew growth on sized cotton, Shirlan is used for the prevention of mildew in wool, sized rayon and tent cloths.

For the latter purpose, tent cloth which has often to resist severe mildew attack is treated with 0.1% to 0.2% Shirlan Paste

or 0.05 to 0.1% Shirlan Powder, dissolved in a solution of Ammonia in water. Waterprcofing and mildew proofing may also be applied to tent cloth simultaneously by the use of Shirlan and a one bath waterproofing agent such as Waxol from the same bath. The following is a typical formula for this work:

12-16 lbs. Waxol W.
6½-18 ozs. Shirlan Paste.
1 pint Acetic Acid (80%).
Bulked to 40 gallons with water.

The water soluble form of Shirlan, **Shirlan NA,** is particularly useful as a mildew antiseptic for addition to water used in oonditioning cotton and worsted yarns. For conditioning of cotton yarns, a solution containing 3 lbs. Shirlan NA in 100 gallons of water is sprayed on. For cenditioning vollen yarns, where approxlmately 5% conditioned moisture is added, a solution containing 2 lbs. of Shirlan NA per 1o gallons of water is recommended.

CHAPTER XXXI.

"GLOSSARY OF CHEMICAL TERMS," Etc.

Acetic Acid.—This acid may be used with advantage in bleaching. Commercial acetic acid should contain 33 per cent. of real acid ($HC_2H_3O_2$).

Acetic acid or or Vinegar is used for increasing the lustre of silks and brightening the colours of silsks oy wool, and it has also the effect of making wool feel soft and silky to the touch. A teacupful of vinegar may be added to 2 gallons of water and used as a final riuse, while washing on a large scale, 1 teacupful of 36 per cent acetic acid can be added to 10gallons of colc water.

Acetic Ether.—Chemically termed as ethyl acetate.

Acetate of Copper.—is Verdigris.

Adulteration.—is legally defined as, the act of debasing a pure or genuine article for pecuniary profit by adding to it an inferior or spurious article, or taking one of its constituents away. The species of adulteration may be divided into three clases namely :—

(1) *Accidental or careless.*—This is often self—evident, or easily detected and seldom occurs if the articles are supplied by a firm of reputation.

(2) *Ignorant.*—This is seldom met with now. It is so easy to detect. It does not pay.

(3) *Deliberate and Skilful.*—This is the class to be afrraid of.

Cheap substitutes are never as good as the real thing. It cost a great deal more in the long run.

Air.—is composed of about twenty–three parts (by weight) of oxygen and seventy–seven parts of nitrogen, or twenty-one parts (by volume) of oxygen and seventynine parts of nitrogen.

Acid.—Substances having a sour taste, and which are capable of changing vegetable blue colours to red, and of neutralizing alkalies by combining with them and forming salts, are called acids.

Acids and Alkalies.—Water may be alkaline, neutral, or acid, but it is generally alkaline.

Some waters are acid, although this is rare, except where waters are drawn from coal mine ; or from the vicinity of coal beds. These waters may become quite acid with sulphuric acid, which is produced by the oxidization of the pyrites or sulphide of iron that is always found with coal.

Water from the neighbourhood of coke ovens and gas works often contains sulphate of ammonia, which is excessively corrosive and eats through boiler plates very quickly. Sulphuric acid may be found in feed water taken from the neihgbourhood of tin-plate works, steel works, and galvanizing works, where pickling vats are in use.

Acid of Sugar—The common name of oxalic acid.

Adhesives—Substances which hold particles together and are made of starches, gums, glues, etc.

Alkali—Substances having a caustic taste, feeling soapy to the touch, volatilizable by heat, soluble in water, capable of changing vegetable red to blue and of combining with, and thereby neutralizing acids, are called alkalies. Such as caustic soda, caustic potash, lime water and ammonia.

Alum—A double sulphate of aluminium and potassium.

Alum is used for rendering flannelette or any other thin cotton materials non-inflammble. After being washed and rinsed, the garment should be squeezed dry and immersed in a strong solution of alum and water. Dissolve 2 ozs. of alum in one quart of boiling water and use when the solution is cool.

Aluminium Sulphate—Sulphate of aluminium, like sulphate of iron, is one of the most virulent corrosive salts naturally present in water. If the compound known as aluminoferric is used for softening feedwater, it must afterwards be completely removed to prevent corrosion by aluminium sulphate.

Amide—Emulsifies any kind of oil such as castor oil, cocoanut oil etc. Add 1 ounce of Amide to 100 ozs. of oil. Mix amide in 5 ozs. of hot water and then mix this solution to the oil (half quantity first) and then gradually add the rest of the oil. Stir well while adding the oil.

Ammonia—This liquid is the solution of the gas ammonia which is a compound of two gases, hydrogen and nitrogen. It has strongly alkaline properties, and when added to any acid, neutralizes it and

if added to some salts has the power of combining with their acids and settling them free and so, in many cases, precipitating their bases. One pint of liquid ammonia mixed in two gallons of water and this again mixed in 50 gallons of water and 400 lbs. of farina brightens the fast coloured stripes in cloth. The mixture should be used in colour sow-box and boiled to a paste.

Ammonia Solution—Ammonium hydroxide.

Ammonium Chloride—This is solid crystalline body, which is sold in tough fibrous lumps or in powder, the latter being more convenient. The solution is prepared by filling bottle intended to hold the liquid, to about one-third its capacity, with the small crystals or powder, then filling it completely with distilled water, and shaking up occasionally till the water has dissolved as much of the salt as it can, the operator may then either filter the solution through filter paper to separate any insoluble particles, and store the fluid in a clean bottle, or allow any insoluble matter together with the crystals which are not dissolved, to settle to the bottom, and use the clear liquid taking care not to shake the bottle previous to use.

Ammonium Sulphide—It is a combination of hydrosulphuric acid gas with ammonia, and is prepared by passing hydrosulphuric acid gas through ammonia till the liquid ceases to produce a white precipitate when a few drops of it are mixed with a small quantity of a solution of sulphate of magnesia. This may be bought and kept in the liquid form. It is liable to change to a deep yellow colour in course of time, but this change does not interfere with what is required of it. It should however be kept in well stoppered bottle, otherwise it will decompose and become useless.

Ammonium Oxalate—This salt which is obtained in small crystals, is a combination of oxalic acid, and organic body with ammonia. The solution is prpared as in case of ammonium chloride.

Antiseptic—Sizing—chloride of zinc, glycerine, etc.

Aqua Fortis—Nitric acid.

Aqua Regia—A mixture of 18 parts of nitric acid and 82 parts of hydrochloric acid used for dissolving gold.

Baking Soda—Soda Bicarbonate.

Barium Chloride—This salt is a combination of barium and chlorine and is used for testing sulphuric acid and sulphates. It is obtained in small crystals.

Baryta, Heavy Spar—Barium oxide.

Barytes—Barium Sulphate.

Benzine—Refers to petrol.

Benzine is a highly purified fcrm of pe rol It is an excellent cleaner, and is suitable for removing small grease or oil spots.

Benzoyl Peroxide—is a very active bleaching agent for fats. It is a crystaline powder melting at 103°C and soluble in oil. For bleaching oil it is used in the form of a very fine powder. The quantity to employ varies, from 0.05 to 0.2%. The best temperature seems to be 80° to 90°c.

Beta or B Naphtol—To prepare a testing solution proceed as follows. Put a teaspoonful in a cupful of caustic soda solution, the powder dissolves and this solution can be kept in a corked bottle and used as required.

Bleaching Powder—Chloride of line and hydrochloric acid. To prepare a testing solution proceed as follows :—

A little of the bleaching powder (to cover 4–anna silver bit) is placed in a 3–in. basin. Fill up with water, stir well, then put the threads in. Keep this chemical in a bottle with a cork, and not a glass stopper.

Blue Vitriol, Blue Stone—Sulphate of Copper.

Blue Bilby—for lining furnaces, is pure oxide of iron.

Boiler Scale—is carbonate of calcuim.

Borax—Sodium tetraborate. Borax may be used in pure size 1 to 1¼% on the weight of starch for an antiseptic.

An ounce of borax in a pint of hot water, makes a good hair wash and removes scurf or dandruff. The head should be afterwards washed in cold water and carefully dried.

Milk can be preserved and kept sweet for some time by adding to each quart about half a thimbleful of borax which has been dissolved in a table-spoonful of hot water.

Butter also may be preserved, by washing the cloth with which it is to be wrapped, in a solution of borax.

Sprinkled in places in the form of powder where there are insects, it has the desired effect of ridding these pests.

Brimstone—Sulphur.

Burnetts Disinfecting Fluid—Chloride of zinc Solution.

Butter of Antimony—Antimony Trichloride.

Calamine—Sulphate of Zinc.

Calcuim—The metallic base of lime.

Calcuim Carbonate—Carbonate of lime is the commonest form in which lime occurs in water. It is but slightly soluble in chemically pure water, but when carbonic acid is present it is found in the form of bicarbonate of line, which is quite soluble. Bicarbonate of lime, when carried into a boiler, is decomposed by the heat, the carbonic acid is driven off with the steam and normal carbonate of lime is formed, which is practically all precipitated in the boiler when the temperature reaches 290°F. Carbonate of lime alone does not form very hard scale, but it is responsible for a good deal of the mud that is found in boilers. However, it may form part of a very hard scale when materials that cement it to the plates and tubes of the boiler are present.

Calcium Chloride—Chloride of calcium is sometimes found in natural water, in which it is very soluble. It is not liable to cause corrison directly, but if Magnesium Sulphate is present the corrosive Magnesium Chloride is formed. Sodium Carbonates precipitates calcuim chloride as a carbonate, leaving Sodium Chloride in Solution.

Calcuim Nitrate—Calcuim nitrare rarely occurs, and even then the quantity is usually very small. Of itself it does not form boiler scale, but in the presence of sulphate of soda an exchange of acids takes place in the boiler and the nitrate is converted into sulphate of lime. It is liable to decompose at high temperatures and liberate corrosive acids.

Calcium Sulphate—Sulphate of lime, commonly called gypsum or plaster of Paris, is a common constituent of natural water and is responsible for the hardest kind of boiler scale, this scale sometimes being as hard as porcelain. It is almost entirely precipitated at 260° Fah. when the boiler pressure is about 50 pounds, precipitation being in the form of heavy crystals that at once fasten themselves to the boiler plates. Sulphate of lime adheres to the plates of a boiler much more firmly than carbonate of lime.

Calomel—Chloride of Mercury.

Carbolic Acid—Phenol.

Carbolic Acid—Carbolic Acid is found in all natural waters, it is the gas used in soda waters, and is responsible for the presence of many minerals, as it holds them in solution in the water.

Carbon—Pure charcoal.

Cast-iron Grey—is composed of iron 90.5 parts; combined carbon 1.5; graphite 2.8; Silicon 3.1; Sulphur 1.1; manganese .6; and Sulphur .4 parts.

Castor oil—By shaking rancid castor oil with water and calcined magnesia the rancidity can be removed.

Caustic—Caustic is the abbreviated name of lunar caustic. It is actually the solution of silver nitrate.

Caustic Potash—Hydrate potassium.

Caustic Soda—Sodium hydroxide. It is advisable to store this substance in the solid form, and to keep in well corked or stoppered bottles. The commercial purpose is all that is served by this.

1.77 lbs. of solid caustic soda to 1 quart (liquid) at 70° Tw. for a mixing of 1400 lbs. (out of which the proportion of solids should be about 500 lb).

¼ to ½ lb. of solid caustic soda at 70° Tw. if added to 300 lb. of Farina will give good results as a light mixing. But bear in mind that no chlorides should be used with C. Soda otherwise precipitation will take place of either of the chlorides.

To prepare a testing solution proceed as follows :—

Dissolve about one and a half sticks in a cupful of water, which becomes hot, stir with a glass rod, don't Splash. Do this carefully and do not touch the sticks with the fingers.

Chalk—Carbonate of lime, Calcium Carbonate.

Chinese Blue—Prussian Blue.

China and Earthenware Cement—Dilute white of an egg with its bulk of water; mix to the consistency of paste with powdered quicklime.

China and Earthenware Cement—Dissolve isinglass in hot water, and add acetic acid.

China Cement.—Finely powdered glass, mixed with white of an egg.

China Clay—Aluminium Silicate.

Chinese White—Zinc Oxide.

Chloroform—Chloride of formyle. When using, as a testing solution, use very little, just enough to cover the threads or sample and allow to stand for about 6 minutes.

Cictric Acid—A lemon juice preparation.

Coconut Oil—has the propoety of mixing more readily with Epsom Salt than any other oil or fat. Also with whiting powder for preparing white stamping paste.

Common Salt—Sodium Chloride.

Copperas, Green Vitriol—Sulphate of iron, or Ferrous Sulphate.

Corrosive Sublimate—Bi-chloride of mercury.

Cream of tartar—Bitartate of potassium.

Cresol—Cresylic Acid.

Crucible—Pots intended for heating solids to a high temperature.

Deliquescence—Absorption of moisture from air.

Dextrose—Glucose.

Dextrine—A gum prepared from potato starch.

Digest—To steep for impregnation.

Dry Alum—Sulphate of aluminia and potash.

Ebonite—India—rubber mixed with half its weight of sulphur.

Emeral Green—Sesquioxide of chromium.

Emery—The rough massive varieties of corudum, much used as an abrading agent. It is used in the form of powder for grinding hard surfaces, or is formed into solid hones or into small wheels for sharpening tools of hard steel.

Emulsion—A mixture of oils and water which do not naturally mix.

Epsom Salt—Magnesium sulphate.

Ether or Sulphuric Ether—It is a highly inflammable and volatile liquid produced by the distillation of alcohol with sulphuric acid.

Ethiops Mineral—Black sulphide of Mercury.

Ferro-Manganese—Pig iron containing more than 20 per cent of manganese.

Flake white, Pearl white—is oxidized carbonate of lead or Bismuth Submitrate.

Fluor Spar—A mineral composed of fluoride of calcium.

French Chalk—consists of ground silicates, such as soap stone and talc. It is a soft, white, granular variety of steatite. Steatite is a variety of talc, and is of a grayish green or brown colour. It is also known as soapstone. It is used as a filler in Starching.

Fuller's Earth—is a soft earthy substance resembling clay., but not plastic like clay. It occurs in nature as an impure aluminium silicate. It is sometimes used as a filling material.

Gall-nut Solution.—Gall-nuts are globular in form, and have irregular projections all over their surface. It is used for the purpose of making ink for stencilling yarn or cloth bales. The ink can be prepared as follows :—

Gall-nuts = 10 lbs. sulphate of iron = 3 lbs.

Remove and throw the seeds away and then crush to small bits the outer portion of the nuts, mixing 3 gallons of hot water to both the ingredients. Allow it to steep 2 to 4 days. To intensify the colour add ½ to 1 lb. of victoria blue or the waste water of black sulphur colour from the dye house use for stenciling ink.

Galena.—Sulphide of lead.

Galvanising.—Coating with zinc.

Gamboge.—A gum resin from Siam.

Gasolene.—Petrol.

Gelatine.—An albuminous substance used in the preparation of adhesives, etc.

Gelatine is a substance obtained by boiling ossein or collagen in water. The Ossein is a constituent of the bones and the collagen of the skins of animals. The bones are treated with sulphuric acid to remove the mineral structure, after which the flexible substance (ossein) remaining may be cleared in prolonged water boiling. Glue is an inferior quality of gelatine.

Gelatine is a nitrogenous colloid. It is soluble in water, and forms a jelly on cooling. It is the chief ingredient of isinglass and glue. It is used extensively in finishing and printing, in the size as a binder. Gelatines and glues appear commercially in shades varying from pale amber to dark brown. The lighter shades are obtained by bleaching the gelatinous liquors with sulphurous acid or sulphur dioxide before drying. The bleaching does not injure the quality of the substance.

German Silver.—An alloy of 52 parts copper, 26 parts zinc and 22 parts nickel.

Glauber's Salt.—Sodium sulphate.

Glucose.—Grape sugar and potato starch, dextrose.

Gluten.—Does not swell when treated with water but combines with a definite quantity, acquiring a certain degree of tenacity. It is very adhesive to solid bodies, paper, linen, etc., whenever it comes in contact with them. It is important to estimate the quantity and quality of the gluten the flour contains,—it varies from 1 to 20 per cent.

Glue.—Gelatinous body from hoofs and horns of animals.

Glycerine.—Fat, decomposed with high pressure steam.

Goulard.—Subacetate of lead.

Grain Alcohol.—Ethyl, Alcohol, Ethanol.

Granules.—Small particles of starch.

Gritty Matter.—Hard undissolved particles.

Gun Cotton.—Nitro cellulose.

Gunpowder.—Consists of nitre 75; charcoal 15; and sulphur 10 parts.

Gypsum.—Calcuim Sulphate.

Horn Silver.—Silver Chloride.

Hydrosulphite.—Sodium Sulphite, formaldehyde; it is a grey powder. To prepare the testing solution proceed as follows :—

Put a pinch in about two teaspoonfuls of water. Boil the water in a small 2-in. basin and add the powder, boil again for about one minute, place the sample or threads to be tested in the water whilst the powder is being added. Solution should be made fresh for each test.

Hygroscopic.—Absorbing moisture from the air.

Hypo.—Sodium Thiosulphate.

Impervious.—Not admitting passage to water.

Indian red.—Ferric oxide.

Iodine Solution.—For chemical test of cloth prepare as follows—Ten grains Potassium iodine dissolved in 100 grains of water $\frac{1}{10}$th grain Iodine added to it and the whole made up to a solution.

Iodine Tincture.—Iodine dissolved in Alcohol.

Iron.—is generally present in water in the form of bicarbonate, but as iron bicarbonate is a very unstable compound, it quickly gives out its excess of carbonic acid, and, absorbing oxygen, is converted into iron rust. This explains why many waters turn red when exposed to the air for a short time. Red water in the gauge glass indicates the presence of iron, and should be seen to at once. Carbonate of iron causes boiler scale. Waters from the vicinity of coal beds sometimes contain sulphate of iron, which is fairly soluble and is precipitated as a scale of iron salts. When deposited, strongly corrosive acids are liberated.

Iron Pyrites.—Bi-Sulphide of iron.

Isinglass.—A gelatine (pure) from the internal membranes of the bladders of the sturgeon.

Jewellers Putty.—Oxide of tin.

Kaolin.—China clay, aluminium Sili-cate.

Kings Yellow.—Sulphite of arsenic.

Lamp Black.—the soot from the smoke of burning pitch.

Lard.—Fat of the hog.

Laughing gas.—Nitrous oxide.

Lead Acetate.—Whitish crystal powder. To prepare a testing solution proceed thus:—Place a little in water, can make any strength required.

Levigation.—The reduction of lumps and hard parts of substances to pulverulent form by grinding in water or other liquid.

Liquid Glue.—White glue, 16 oz.; dry white lead, 4 oz; soft water, 2 pints; alcohol, 4 oz.; Stir and bottle while hot.

Liquid Glue.—Glue, 3 pints, softened in 8 parts water; add ½ pint muriatic acid and ¾ pint sulphate of zinc; heat to 176°F. for 12 hours; then allow it to settle.

Lime.—Calcuim oxide.

Lime Slaked.—Calcuim hydroxide.

Linseed Oil.—This valuable oil is obtained by pressure from the seed of the flax plant. Linseed contains on an average about 38 per cent. of oil, though the amount varies materially, the percentage obtained fluctuating considerably, not being alike on two successive days. This is partly due to the varying richness of the seed, and

partly to the manner in which it is manipulated in extracting the oil, it being a very easy matter to lose a considerable percentage of the oil by a lack of skill in any of the processes, though they all seem so simple.

Litharge.—Lead monoxide.

Lithia.—Oxide of lithium.

Litmus paper.—Blotting or filter paper soaked in a solution, litmus, turns blue with acids and red with alkalies.

Lubricants.—Preparations used to decrease the friction between opposed solid faces which arises from true cohesion.

Lunar Caustic.—Nitrate of silver.

Lye.—A solution of alkali, such as caustic soda, much used in soap making.

Magnesia.—Magnesium oxide.

Magnesium Carbonate.—Carbonate of magnesium in its commonest form is known as magnesia. It behaves in exactly the same manner as carbonate of lime, its bicarbonate being soluble, and its normal carbonate being practically insoluble. Magnesium carbonate is much used as lagging for boilers and is an excellent non-conductor of heat, but when in the form of boiler scale is on the wrong side of the shell.

Magnesium Chloride.—Chloride of magnesium is a very objectionable mineral when present in boiler water, being very corrosive in its action, quickly pitting and grooving boilers that use water containing it.

Magnesium Sulphate.—Sulphate of magnesium, commonly known as Epsom Salt, is a common constituent of natural waters, in which it is extremely soluble. It does not, of itself, form boiler scale, but is broken up by the lime salts when present in the water, and forms scale. Both sulphate and carbonate of magnesium may interact with chlorides and form corrosive acids.

Marl.—An earth, containing carbonate of lime.

Marmolite.—Silicate of Magnesia.

Massicot.—Yellow oxide of lead.

Meerschaum.—Silicated Magnesian clay.

Mercerization.—A treatment by which a silk-like lustre is given to cotton clothes or yarns when they are treated with a solution of caustic soda.

Metallic Oxide.—A metal combined with oxygen.

Methylated Spirits, Wood Alcohol.—Methyl Alcohol—Methanol. The methylated spirit of commerce usually consists of the ordinary mixed grain, or plain spirit, as produced by the large distillers in London and elsewhere, with which are blended, by simply mixing in various proportions, one part of vegetable naphtha and three parts Spirits of Wine.

Mica.—is a transparent mineral.

Mosaic Gold.—Bi-Sulphate of tin.

Muriatic Acid.—Hydrochloric Acid.

Muriate of Soda.—Common Salt.

Muriate of Lime.—Chloride of Calcuim.

Neutralization.—The removal of acidity or alkalinity from a solution to a neutral state by means of an alkaline or acid solution..

Nitre or Saltpetre.—Nitrate of potash.

Nut-Galls—These are found upon the young twigs of the Turkish dwarf oak, and are produced by the puncture of in snsect called cynips. The supply is principally from Turkey and Aleppo Nut-galls contain a large quantity of tannin and gallic acid, and are extensively used in dyeing.

Ochre.—The hydrated sesquioxide of iron.

Office Paste.—Strong, and does not soon turn sour: ½ oz. alum, dissolved in 1 pint of water; add 1 lb. of flour, and when boiled, add ¼ oz. resin, and again boil until properly dissolved and mixed.

Oil of Vitriol—Sulphuric acid.

Orpiment.—Arsenic Trisulphide.

Oleic Acid.—Red oil.

Pearl Ash.—Potassium Carbonate.

Phenol.—Carbolic acid.

Plaster of Paris.—Sulphate of Calcuim.

Plumbago, Black-Lead.—Graphite.

Potash.—Potassium hydrate.

Precipitate.—To deposit or fall in the solid state out of a solution.

Precipitated Chalk.—Calcium Carbonate.

Prussian Blue.—Ferric—Ferrocyanide; prussiate of potash.

Prussic Acid.—Hydrocyanic acid.

Pumice—Stone.—This well-known light and spongy volcanic substance is extensively quarried in the small islands that lie off the cost of Sicily. Pumice-Stone should not be allowed to stand in water, it causes the grain to contract and to harden, thereby deteriorate its cutting properties.

Putty.—A mixture of whiting and 18 per cent. linseed oil, with or without the addition of white lead.

Putty Powder.—Levigated oxide of tin.

Pyro.—Pyrogallic acid.

Quick lime.—Calcuim oxide.

Quick Silver.—Mercury.

Rectified Spirit.—Alcohol 90 per cent.

Red Lead.—Oxide of lead.

Resins.—A class of uncrystallizable vegetable products which are insoluble in water as distinct from gums.

Rochelle Salt.—Potassium and Sodium Tartrate.

Sal Ammoniac.—Ammonium chloride.

Sal Soda.—Sodium carbonate—crystalline.

Salt.—Sodium Chloride.

Salt of Lemon.—Oxalic acid.

Saltpetre.—Nitrate of potash.

Salt of Hartshorn.—Ammonium Carbonate.

Salt of Tartar.—Carbonate of potash.

Salt of Sorrel.—Potassium Quadroxalate.

Salt Volatile.—Ammonium Sesquicarbonate.

Saudarach.—This is the produce of the Thuya articulata of Barbary. It occurs in small pale yellow scales, slightly acid, and is soluble in alcohols, it is used in both polishes and varnishes.

Saponification.—A term given to the hydrolytic chemical action whereby fats and oils containing glycerides are converted into soaps. When boiled with a solution of potash or soda, oils and fats are slowly decomposed or saponified, and form soaps, the nature of

which will depend upon the alkali used and the kind of oil or fat. For instance, a very hard soap is obtained from tallow and from earthnut oil, whereas cocoanut fat yields a soft soap, which is readily soluble even in hard waters and is therefore used as the basis of the so-ca led 'marine soap' which will give a lather with sea-water.

Saturation.—The maximum degree to which a liquid can hold a solid in solution at any given temperature.

Silica.—Common sand is nearly all pure silica. Though contained in almost every water, silica is found to the greatest extent in warm waters. It is frequently in combination with alumina, and, except in some few cases, is present in such small quantity that it has little to do with the formation of boiler scale.

Slaked Lime.—Hydrate of Calcium.

Smelling Salt.—Carbonate of Ammonia.

Soap Stone.—Magnesian Mineral.

Soda.—Sodium Carbonate.

Soda Ash.—Commercial Sodium carbonate.

Soda Crystals.—Sodium carbonate in crystal form, commonly known as washing soda.

Sodium Nitrate.—In sticks, keep well stoppered in a bottle. To prepare a testing solution proceed as follows :—Break off a small piece and put into 3 in. basin, with water. When dissolved, add H. Cl (3 or 4 drops). No heat is required. Place the threads or sample in the solution for a few minutes and then wash well. For each test a fresh solution should be made.

Sodium Sulphate and Sodium Chloride.—Comonly known as Glauber's salt and common salt, respectively, do not form boiler scale nor corrode iron; they are not objectionable unless present in very large quantities when they may cause foaming or priming in the boilers.

Sodium Carbonate.—Carbonate of soda, or washing soda, does not form boiler scale nor cause corrosion, but is objectionable when present in large quantity, as it causes foaming.

Soft Soap.—Potash soap, the oil being saponified with potash alkalies.

Spanish Whiting or Chalk.—A variety of soap stone or talc found in spain.

Specific Gravity.—The Specific gravity of a body, is its weight in proportion to an equal bulk of pure water, and the standard of comparison for solids and liquids is a cubic foot of pure water at 62°F., which weighs 1000 ounces avoirdupois.

Spermaceti.—The white crystalline wax obtained from Sperm oil. It does not yield glycerine when saponified. At one time it was used in candles, but is now used as a high grade wax.

Spirit of Hartshorn.—Ammonia.

Spirits of Salt.—Hydrochloric acid.

Stannous Chloride.—White crystal powder. To prepare a testing solution proceed thus :—Dissolve a pinch or two in a 2 in. basin with water, pour into a test tube, add a drop of H. Cl.

Stearin.—The glyceride of stearic acid occuring mainly in solid fats or tallows.

Stucco or Plaster of Paris.—Sulphate of Calcium.

Sugar of Lead.—Acetate of lead.

Sulphuric Acid (concentrated)—A heavy oily liquid having a specific gravity of about 1.835. Vitriol (H_2SO_4).

Sweet Spirits of Nitre.—An alcoholic solution containing about 4 per cent. ethyl nitrite. It is a clear mobile liquid, yellowish in colour and of a fragrant odour. Used medicinally.

Talc.—Magnesian Mineral.

Talcum.—A hydrated magnesium silicate, greasy to the feel and occuring in plates or granular form. It varies in colour from white to grey, green, brown and red.

Tallow.—Fats of ox and sheep.

Tartar Emetic.—Antimony and Potassium tartrate.

Thus.—Thus is the resin which exudes from the Spruce-fir, and is used by some polishers in the making of polishes and varnishes.

Tin Ashes.—Stannic oxide.

Tranmaticin.—A solution containing about 15 per cent gutta percha in chloroform. Used like collodion.

Tripoli.—A form of silica originating from the decomposition of chert or of limestone rich in silica. Often confused with tripolite which is diatomaceous earth. True tripoli contains no diatoms. It is used in detergents, for polishing and as a paint filler.

Turkey Red Oil.—Sulphuretted castor oil. As the name indicates, these products were first used in the turkey red dyeing trade, their function being to fix the dyeing. The initial discovery was due to the German chemist Runge who demonstrated over a century ago that a product could be obtained by treating oleic acid with sulphuric acid. Later, Mercer in England was able to sulphonate olive oil, whilst the subsequent discovery that castor oil could be sulphonated considerably cheapened the end product.

Turkey red oil is produced nowadays by acting on castor oil with sulphuric acid, the excess of the latter being removed after the sulphonation. The reaction mixture is then neutralized by sodium, potassium, or ammonium by hydroxide and applied to textile work in the form of the appropriate salt.

The reaction, which is complicated, was not thoroughly understood for a long time and can only be shown here in a simplified form. The sulphuric acid acts not only as a sulphonating agent, attaching itself to the fatty molecule, but a series of simultaneous reactions takes place in which the neutral fat molecule is widely split. Besides this, according to the Chemical Composition of the castor oil, there is the possibility of polymerization and the formation of anhydrides. The main reaction, however, together with the cleavage, must be considered as the attachment of the sulphuric acid to the fatty molecule.

With castor oil, which is an unsaturated oxy-fatty acid, the sulphuric acid reacts with the OH-group present in the molecule in such a way that water is eliminated and a sulphuric acid tester formed.

Turpentine.—The oil obtained by distillation of the oleo-resin derived from various species of pine tree. It is used in paint and varnishes, in the manufacture of rubber, perfume and artificial camphor.

Umber.—A paint pigment consisting of a brown siliceous earth manganese oxide and hydrated iron oxides. Burnt umber made by heating umber is much redder in colour.

Venetian Red.—Red iron oxide pigments varying in chemical composition. Chiefly applied to the light red to distinguish it from the dark shades called Indian red.

Venice Turpentine.—An exudation from the larch, found in Europe and so named from the city whence it was supplied. Used in medicine.

It is a ropy liquid, colourless or brownish green, having a somewhat unpleasant odour and bitter taste.

Verdigris.—Acetate of Copper.

Vermilion.—Sulphide of mercury.

Vinegar.—4 per cent acetic acid solution.

(1) A rag soaked in vinegar removes rust more quickly than anything else.

(2) When the painters brush has touched the window glass, the paint can be removed quite readily with a coin dipped in hot vinegar.

(3) Equal quantities of vinegar and paraffin restore the whiteness to bath or wash basin with hardly any effort, while an equal quantity of vigenar and olive oil are excellent for cleaning furniture or paint.

(4) Vinegar in the water in which a glass is washed, or windows and mirrors cleaned gives a brilliant polish quickly.

(5) A few drops added to the shoe paste makes the leather shine longer and more brightly.

(6) To rid knives and cooking utensils of a strong smell, wash them with water containing vinegar.

(7) If a teaspoonful of vinegar is added to every quart of water used in rinsing silk or cotton material, the colours are all the sharper. A desert spoonful to a quart of cold water clears off the soap and brightens fair hair when used as the last rinse.

(8) When an aluminium saucepan is discoloured boil a little vinegar and water in it to remove the stain.

(9) Vinegar added to the water in which kitchen cloths are boiled kills the grease and whitens them.

(10) A little vinegar added to the solution when dyeing makes the dye take better.

(11) Vinegar and water will freshen the colour of the carpets and tapestry, and take the shine off serge suits and costumes.

(12) Vinegar applied freely will prevent poisoning from dog or insect bites.

(13) Malt vinegar dabbed on a bald spot of human head will cause the hair to grow again.

(14) A few drops of vinegar on a lump of sugar will ease a cough or sore throat.

(15) A 50 per cent solution of vinegar and warm water is a splendid gargle or wash for small wounds.

(16) When spring cleaning or turning out, vinegar added to the water for washing furniture, paint and windows halves the work.

(17) A tablespoonful of vinegar in a small glass of soda water (mineral) will cure the headache of the one that has celebrated too well and prevent that morning after feeling.

(18) Vinegar should be avoided by those subject to gout.

(19) Vinegar added to grate or shoe polish that has dried in the tin will give a splendid polish.

(20) Dont immediately send for the plumber if the sink is stopped up. Instead try putting a large lump of soda, with plenty of vinegar poured over it, just at the outlet. This causes an efferves-cence which will clear the most stubborn stoppage.

(21) Before setting out on a journey sponge your skin, especially the face, arms and legs with pure malt vinegar and allow it to dry in. This, you will find keeps you delightfully cool, and insects of all kinds will give you a wide berth all day.

Vinegar Salt.—Calcuim acetate.

Volatile Alkali.—Ammonia.

Volatile Salt.—Ammonia.

Vulcanite.—India-rubber mixed with half its weight of sulphur.

Washing Soda.—Sodium Carbonate.

Washing Crystals.—Crystallised soda and 2 per cent borax.

Water.—Oxide of Hydrogen.

Water-proof cement.—Powdered resin, 1 oz, dissolved in 10 oz. Strong Ammonia.

Water-Glass.—Sodium Silicate. A white soluble sodium silicate having a glassy appearance when hard.

Whiting.—Calcium carbonate, pure chalk.

White Copperas.—Zinc Sulphate.

White Lead.—Lead carbonate. A widely used paint pigment. A mixture of lead carbonate and hydrated lead oxide.

White Magnesium.—Carbonate of Manganese.

White precipitate.—Ammoniated mercury. A compound of ammonia and corrosive sublimate.

White Pyrites.—A sulphuret of iron.

White Vitriol.—Zinc sulphate.

White Wax.—A bleached and purified quality of beeswax.

White Zinc.—Zinc oxide.

Wool Grease, Wax or Wool Degras.—The oily material present in the sheep's wool, technically a wax containing no glycerine or glycerides. It is extracted from the cut wool with alkali soap solution or with sodium carbonate.

Wood Tar.—The bituminous product derived from the destructive distalation of wood, varying in properties with the source and quality of the wood used.

Yellow Wax.—Common beeswax so called from its colour. When new it is light yellow darkening with age. It is bleached and called white wax. Used for polishes, candles and floor waxes.

Zinc Chloride.—Zinc dissolved by hydrochloric acid.

Zinc White.—Zinc oxide.

Zinkenite.—An ore of antimony and lead.

SYMBOLS & ATOMIC WEIGHTS OF ELEMENTS.

Element.	Symbol.	Atomic Weight	Remarks.
Hydrogen	H	1	
Carbon	C	12	
Nitrogen	N	14	
Oxygen	O	16	
Sulphur	S	32	

*Recipes.

(1) Recipe for preparing "Resin Size."

Dissolve 20 pounds of powdered caustic soda in 9 gallons of boiling water in a steam jacketed pan, and then add gradually 150 pounds of fine powdered resin, keeping the mixture well agitated until thoroughly saponified.

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(2) Recipe for "Office Mucilage."

Dissolve 1 lb. of gum arabic in 1 quart of water and add 4 oz. of glycerine. This makes a very useful flexible adhesive, whereas ordinary gum arabic mucilage is brittle and cracks, and will not adhere to smooth surface without peeling off.

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(3) Recipe for "Label Paste."

A good paste for labels may be made by soaking glue in strong vinegar, then boiling up and adding flour. This is very adhesive, and will not decompose when kept in wide-mouthed bottles.

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(4) Recipe for "Adhesive Paste."

Wheat flour 1 lb., gum arabic 12 oz., gum tragacanth 3 oz., Salicylic acid ½ oz., oil of cloves ½ oz., water 1¼ gallons. Heat the water, then dissolve the gums in part of it. Make a batter of the flour with another portion of the water. Stir well and mix with the gum water; then add the acid and cloves dissolved in water, and just bring to the boil together and strain while hot.

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(5) Recipe for "Starch Paste."

(*a*) Starch = 4 oz.
White Destrin = 2 oz.
Cold Water = 10 fluid oz.

(*b*) Borax = 1 oz.
Glycerine = 8 fluid oz.
Boiling Water = 64 fluid oz.

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*The recipes are given here only by way of information and guide as so much depends upon proper manipulation, suitable qualities of chemicals and materials and correct working conditions etc. etc.

Beat to a paste the ingredients given under (*a*). Dissolve borax in the boiling water, then add the glycerine, then pour (*a*) mixture into the solution of borax (*b*) Stir until it becomes transparent. The paste will not crack, and, being very pliable, is used for paper and even cloth leather where flexibility is required.

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(6) " Damp Proof Glue."

Dissolve white glue 20 parts in water by sufficient heat. Mix 2 parts of potassium bichromate with 10 parts water. Mix the above two solutions stirring well and put the mixture in tin box to congeal. When using melt the preparation in a cup standing in boiling water. Furniture may be exposed to the sun for some time after using the glue.

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(7) "Glue for Plywood."

Boil the desired quantity of glue with water when sufficiently boiled pour it into a porcelain dish and rub with a pestle into a thick paste free from lumps. Then pour it into an earthenware dish, let it cool, and cut it into pieces of desired size. When it is to be used dissolve 2 parts of the prepared glue in 1 part ordinary whisky diluted with 2 parts of water and let it boil up once. The glue is now ready for use and can be kept for sometime.

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(8) "Adhesive for Pasting Cloth."

Solutions of gum arabic, or dextrin mixed with acetic acid, are frequently employed in the case of paper.

Flour or starch mixed with water containing a little alum, which is then heated to boiling and when cold mixed with oil of cloves, thymol, phenol, or salicylic acid, so as to preserve it, makes an effective adhesive for cotton goods. A transparent paste may be made by the use of rice starch instead of ordinary flour.

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(9) " Adhesive."

Soak 1 pound of good glue in 1½ pints of cold water for 5 hours, then add 3 ozs. of zinc sulphate and 2 fluid ozs. of hydrochloric acid and keep the mixture heated for 10 or 12 hours at 175° to 190° Fah. The glue remains liquid and may be used for sticking a variety of materials.

(10) "Adhesive."

Soak and dissolve gelatin in twice its own weight of water at a very gentle heat; then add glacial acetic acid in weight to the weight of the dry gelatin.

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(11) " A good recipe of Paste."

25 lbs. Farina or Maize Starch.
10 gallons water.
5¾ lbs. Caustic Soda at 66° Tw. and 6 gallons of water.
14 lbs. Sulphuric acid at 25° Tw.

(1) Mix 25 lb. Farina in 10 gallons of water (2) add gradually the caustic soda solution but constantly stir the mixture while adding the alkali (3) allow it to stand for about 3 hours (4) add the sulphuric acid (5) Test after standing the preparation for alkali and acid by means of litmus paper. The greatest care must be taken in ascertaining that no free sulphuric acid is left in the mixture. Should there be found an excess of alkali in the preparation, this can be neutralised with acetic acid if necessary.

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(12) Recipe for "Disinfectant Phenyle."

80 lbs. Rosin.
1 ,, Caustic Soda.
2 ,, Crude carbolic oil or tar oil containing 25% Phenols or 10% on the weight of 1 & 2 of crude carbolic oil.

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(13) " Disinfectant Fluid."

Resin = 3 cwt.
Creosote = 200 gallons.
Caustic Soda 35° B = 30 gallons.
Water = 80 gallons.

Put the resin and water in a suitable vessel and heat together until all the resin is melted, then add the creosote and soda lye, crutch well for 15 minutes, and let it cool.

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(14) " Disinfectant Fluid."

Coal–tar distilate (of sp. gr. exceeding 100)	= 100 parts.
Resin	= 85 ,,
Caustic Soda lye (35° Be)	= 60 ,,
Vegetable oil.	= 20 ,,

Liquefy the resin by the application of gentle heat, add the coal-tar distillate, and when thoroughly incoporated and while the mixture is still warm, add the caustic soda, and boil until saponified. Lastly, pour in the vegetable oil (castor oil, or til oil, or cocoanut oil, etc.)

(15) Recipe for Blue-Black Ink.

Gallic acid	$=1\frac{1}{2}$ oz.
Tannic acid	$=4\frac{1}{2}$ oz.
Ferrous Sulphate	= 6 oz.
Hydrochloric acid (dil.)	=5 oz.
Carbolic acid	=150 grains.
Acid blue	=2 oz.
Distilled water to produce	=10 Pints.

(16) Recipe for Blue writing Fluid.

Dissolve Basic or soluble Prussian Blue in pure water. This is the most permanent and beautiful ink known.

(17) Recipe for " Ink Eraser."

Water	= 4 gallons.
Chloride of Lime	=11 lbs.
Acetic acid	=14 lbs.

Mix Chloride of lime with water. Steam well. Then add the acid and bottle off.

(18) " Black Leather Varnish."

Shallac	=100 parts.
Pine Rosin	= 20 ,,
Venice Turpentine	= 50 ,,
Oil of Turpentine	= 40 ,,
Methylated Spirit	=1000 ,,
Lamp Black	= 40 ,,

When applied to belts, this varnish, which is fairly elastic, soon forms a fine uniform coating, which dries rapidly, and does not easily crack, even when the leather is strongly bent.

(19 " Browning Iron and Steel articles."

Immerse in a solution of tincture of iodine, with one half its bulk of water.

(20) " Black Finish for Small articles of Iron and Steel."

Boil 1 part of sulphur in 10 parts of oil of turpentine, paint the article with it thinly, and heat over a spirit lamp until the required depth of colour is obtained.

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(21) " Coppering or Bronzing Iron and Steel Articles."

Clean and immerse in a solution of sulphate of copper, 3½ oz.; Sulphuric acid, 3½ ozs., water, 1 gallon.

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(22) " Cement for Iron Stove pipes and for filling cracks in Stoves."

Equal parts pulverised clay and fine wood ashes, and a little salt, mix with water to the consistency of putty.

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(23) " Cement for Leather, Canvas, cloth, Parchment etc."

Melt and mix glycerine with glue.

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(24) " Cement for thick leather."

Melt and mix glycerine with glue, and add pure tannin to proper consistency.

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(25) " Cement for fixing Iron Bars into Stone."

A compound of equal parts of sulphur and pitch.

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(26) " Acid-proof cement."

Mix a concentrated solution of silicate of soda. with powdered glass to form a paste.

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(27) " Electric cement for fastening Brass work to glass tubes."

Rosin, 5 oz.; beeswax, 1 oz.; red ochre or venetian red in powder, 1 oz.;

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(28) " Elastic Glue."

Dissolve glue in a water bath; evaporate to a thick fluid, and add an equal weight of glycerine; cool on a slab.

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(29) " Fire-proof cement."

Linseed oil, 4 oz., handful quicklime powdered; boil till thick and cool and harden, then dissolve and use in the same way as ordinary cement.

(30) "Waterproofing Packing Paper."

First dissolve 1¾ lb. of white soap in 1 quart of water; next dissolve 2 oz., of gum arabic and 5 oz., glue in a quart of water; mix the two solutions and heat; soak the paper in the mixture and hang up to dry.

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(31) "Waterproofing Brick Walls."

Soft paraffin wax, 2 lb., Shellac ½ lb.; powdered rosin ½ lb.; benzoline spirit, 2 quarts; dissolve by gentle heat in a water bath; then add 1 gallon benzoline spirit; and apply warm. Being very inflammable, keep it away from fire.

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(32) "Glue for Thin Paper."

Gelatine, 1 lb., dissolved in water, and water evaporated till nearly expelled; add ½ lb. brown sugar, and pour into moulds.

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(33) "Glue to resist Damp."

Boil linseed oil with ordinary glue.

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(34) "Porcelain Cement"

Add plaster of paris to a strong solution of alum.

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(35) "To whiten Silver."

Boil in a solution of:—1 part cream of tartar; 2 parts common salt, and 50 parts water.

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(36) "Gilding Brass, Bronze, and other Metals."

Apply the following mixture at boiling heat:—Cyanide of potass, 2½ lb., carbonate of potass, 5 oz.; cyanate of potass, 2 oz.; the whole diluted in 5 pints of water, containing in solution ½ oz. Chloride of gold, and afterwards varnish the gilt surface.

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(37) "Whitening Brass."

Make a mixture of 2 lbs. grain tin, 1½ lb. cream of tartar, and 1 gallon of water; boil and immerse the brass for a few minutes at a boiling temperature.

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(38) "Frosting of Silver."

Apply with a brush, a solution of water half a pint; cyanide of potassium, 1 ounce.

(39) "Cheapened olive oil."

Olive oil	20 gallons.
Refined cotton oil	10 gallons

(40) "Cheapened Refined Linseed oil."

Refined Linseed oil (all husk extracted)	1 part.
Refined cotton oil (all stearine extracted)	1 part.

(41) "Cheapened Sperm oil."

Sperm oil 10 gallons.
Bright refined cotton oil, (with stearine extracted)—4 gallons.

(42) Cheapened Sperm oil.

Sperm oil.	3 parts.
Whale oil	1 part.

(43) Substitute for Sperm oil.

Deodorised Arctic	1 part.
Best sperm	1 ,,

(44) "Cheapened Cotton oil."

Cotton oil	3 parts.
Cheap Pale Mineral oil (well stirred together)	1 part

(45) "Olive oil Substitute."

Olive oil	3 parts.
Cotton oil	2 parts.
Colza oil	4 parts.
Pale Seal	2 parts.
No. 2 Castor oil	1 part.

(46) "Olive oil Substitute."

Refined Rape	3 parts.
Olive oil	1 part.

(47) Neatsfoot Oil Substitute.

Ox oil	1 part.
Cotton oil	1 part.

(48) "Batching oil."

885 Mineral oil	16 cwt.
A1 Grease	1 cwt.
Water	1 qr.

Mix oil and grease together at 200°F., crutch in water gently. Blow air in to bleach.

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(49) "Batching oil."

American Mineral oil ·885	4 barrels.
Yorkshire Wool Grease	1 barrels.
Water	1 per cent.

Mix the two oils together hot, add the water and crutch in gently, Put into the blower and bleach.

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(50) "Solidified oil M. P. 180°F."

Petroleum jelly	2 parts.
Ceresine Wax	1 part.
Tallow	1 part.
Cotton oil.	1 part.

Melt the above together, and when dissolved add 1% soda crystals (powdered).

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(51) "Hot-Neck Grease."

Take 20 lbs. of soap, cut in thin flakes and dry it. Then take 30 lbs. filtered cylinder oil and 30 lbs. (910) petroleum oil. Mix the two together, and heat to 240° Fah. Then add the soap and stir well, maintaining the heat until the soap and oil have amalgamated, when the mixture may be allowed to cool down. When cool it will be found to be stiff.

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(52) "Paint Brush Cleaner."

(A)	Kerosene oil	2 pints.
	Oleic Acid	1 pint.
(B)	Strong liquid ammonia	¼ pint.
	Methylated Spirit	¼ pint.

Slowly Stir B into A till smooth mixture results.

Directions;—To clean brushes, pour into a can and stand the brushes in it overnight. In the next morning wash out with warm water.

(53) "Aluminium Alloys."

Aluminium	10 parts.
Pure copper	90 parts.

Fuse the aluminium and copper separately in two crucibles and then mix.

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54) "Aluminium A loy for Soldering Aluminium."

Melt 20 parts of aluminium in a crucible. Then add gradually 80 parts of zinc and when this is melted add a small quantity of fat. Stir the mass with an iron rod and pour into moulds.

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(55) "Waterproff French Polish."

2 oz gum benjamin,
½ oz gum sandarach,
½ oz gum anime,
1½ oz gum benzin
1 Pint alcohol.

Mix in a closely stoppered bottle, and put in a warm place till the gums are well dissolved. Then strain off, and add ¼ gill of poppy-oil shake well together, and it is ready for use.

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(56) To Protect Polished Surfaces from Rust. Melt some common resin in a pot and add a little olive oil. Remove the pot from the fire and add a little turpentine. Apply with a brush. The quantity of oil must be found by experiment, it being necessary that the coating, when cold should adhere well, yet be slightly elastic so as not to chip off.

CHAPTER XXXII.

"MILDEW."

Growth of Mildew.

Mildew has been the cause of immense losses to both Lancashire and Indian cotton manufacturers, and the trouble is feared almost as much as an epidemic of Asiatic Cholera or Plague. In every case of mildew in cotton cloth it will be found, as a main factor, that the cloth has been in a damp state. This condition, in the presence of the starch or flour contained in the size, is all that is required for the favourable growth of the objectionable fungi. Even in the presence of preservatives such as, chloride of sinc, etc., mildew will develop if the conditions of dampness, warmth, and absence of free circulation of air, are suitable.

It is from a knowledge of these materials that a remedy can be found to attack these fungi. Examinations, as to the relation temperature has to the growth of mildew, bring out the following points of practical importance :—

(*a*) Mildew can grow—even if only—at temperature nearing those of cold storage.

(*b*) Temperatures high enough to prevent the growth of mildew are impracticable.

(*c*) Temperatures employed in spinning and weaving are very suitable to the growth of mildew.

(*d*) Mildew are many in number and very varied. Each one has its own set of conditions allowing one to flourish in a situation where growth is impossible for another.

(*e*) In considering the humidity factor it is to be noted that lack of moisture may kill the fungus but its spores or germs will still survive and grow out again when moisture is supplied.

Place of Occurrence.

Mildew may establish itself on the pure raw cotton, Infection often takes place in the boll itself after attack by an insect pest. As growth of the fungus proceeds, spores are produced and these are carried by the wind to infect other bolls.

Such an infection must persist during the ginning and baling process and finally arise at the mill. Naturally if the bale has been wet in transit there will have been development of the mildew, but in most cases the infection will be invisible. The important point to remember is that there is nothing in the opening or spinning process which can destroy an infection of this kind. On the other hand, there is a great deal in the temperature conditions of the mill which tends to encourage its persistence; only when a yarn or fibre has been bleached or mercerised can it be taken for granted that an initial infection has been destroyed. When mildewed yarn is examined under the microscope, the mildew can often be seen growing attached to individual hairs like ivy to the tree. Sometimes the fungus can be seen penetrating the cavity of the hair so that this becomes completely filled.

Neppy cotton encourages the growth of mildew. Many neps contain a tiny particle of seed coat, and the oily contents of this offer nitrogenous food to any mildew. Consequently, careless picking, bad ginning, faulty carding, and, in fact, anything which makes for the presence of an abnormal number of neps is to be avoided.

The storage of yarn, especially in cop form, presents difficulties and gives opportunities for mildew growth. If stored in quantity in warm and humid conditions, the cops in the middle of the heap or skip are lying in warm moist unventilated quarters and become especially liable to mildew. Ventilation is essential. The composition of the size may affect (particularly if it is on the acid side) the liability of warp or grey cloth to mildew. Wheat flour is the most liable, and the least liable is farina.

If yarn is too damp and contains insufficient chloride of zinc, the mildew will be accelarated in the bale.

Drops of water falling on to the weaver's beam at the back of the loom from overhead beam or roof built of corrugated iron sheet, the portion that thus gets wet will develop into a line of mildew.

A deep dinge on the drying cylinder or 'lappers' which have not been attended to properly may affect the drying of the yarn sufficiently to cause mildew. If the coloured yarn of the border (*Dhoty* or *Saree*) happened to be sized and insufficiently dried in the process of sizing, mildew will follow, particularly if the size contained inadequate quantity of chloride of zinc, or antiseptic, either in the weaving shed, or when the bales are packed.

When changing for heavy size to pure size, the size vat, the sow box, the feeding pipes, and the flannel, must be cleaned. If cleaning be neglected before use, then mildew takes place, when the pieces are packed in bales, due to the mixture of heavy size containing chloride of magnesium with the pure containing no antiseptic, although there will be present a small amount of chloride of zinc in the heavy mixing. This will be too diluted when it is mixed with the pure size to act as a preservative.

After every stage the moisture of the goods is the most important factor.

The difficulties arising from mildew in cloth are encountered more frequently in bleach works, and dye works than elsewhere. Also fabrics that have been soaped tend more readily than before soaping to develop mildew if they are allowed to remain in that condition for prolonged period.

The amount of moisture present in cloth or material when packed is also one of the causes of mildew. If the moisture exceeds 10% then there is every chance for the growth of mildew. The evidence or indication can be found whether excessive moisture existed at the time of packing from the paper wrappings and tarpaulins.

Frequently the colour from the paper, or possibly the dye in a coloured border or heading, will be found to have marked off on to the cloth, or the ticket will have impressed itself upon the next piece in contact with it.

Pieces can be damaged by mildew resulting from rain water obtaining access to the bale.

When goods are packed in bales, it sometimes happens that the mildew is more distinct towards the outside than the inside of the bale, and this is frequently taken as evidence of external damage from water.

Also the air spaces which are so favourable to mildew growth are found more at the ends and edges of the pieces; and in these spaces the mildew grows most luxuriantly even although the whole bale is attacked to some extent.

Mildew stains are sometimes produced by excess moisture from the gum or paste used on the ticket; in such cases the damage is usually local, being confined to some few thickness of cloth immediately under the label.

Pieces if stamped with ink containing much moisture, the ink should be allowed to dry. This is easily done by spreading out the pieces and allowing them to stand for a little while, and then piled up one on the top of the other for the purpose of bundling up and not as soon as they are stamped.

In deciding upon the cause of damage, it is not sufficient to attribute stains to mildew merely because they have the appearance common to this growth, it is advisable to identify the mildew by observation of the organism under the microscope, and, if necessary to cultivate the growth; stains caused by iron or grease frequently resemble mildew to a remarkable degree.

Prevention and control of Mildew.

The risk of mildew developing on yarn or in cloth may, however, be prevented, or at least minimised, by a judicious use of a suitable antiseptic substance introduced into the size paste with which the warps are sized. But the greatest precaution against this evil is to entirely avoid the exposing of sized yarn, or cloth produced from it, to such climatic and other unfavourable conditions (want of sanitation, good ventilation and dryness) as may not tend to foster the germination of mildew spores which encourage their growth and development.

For perhaps thousands of years it has been known that if a sugar solution be exposed to air and warmth it is gradually converted into a liquid having very different properties, and that, if this liquid be further exposed it becomes sour.

Later it was noticed that bubbles formed during the process and hence arose the term 'fermentation.'

When milk turns sour it is due to the fact that fermentation has taken place and has produced some acid.

Spores (seeds) from certain plants are always present in air and are ever seeking a 'soil' suitable for their developments and growth. The materials that are required by fungi for luxurious growth are ammonia and phosphates. Mildew or mould fungi are plants of microscope size which can grow, spread and reproduce themselves.

It is one of numerous manifestations of the putrifactive or fermentative principle of decomposition which attacks substances of an organic structure and results chiefly from the exposure of such material to the influence of a warmly humid atmosphere. Organic matter in general affords a favourable fertilising medium for the active germination and prolific growth and development of all varieties of moulds and mildew. These growths assume a great variety of distinctive forms chiefly according to their origin and the particular organic nature of the material which is effected, and also the character of the atmospheric conditions to which the substance is exposed. Thus the moulds may manifest themselves only in the form of stains or slight discolorations of yarn or in cloth, or they may occur in the more vigorously active and destructive forms of different spaces of fungus, of which there are more than two thousand varieties of fungi known, and these vary in size from that of a cabbage to a pin point. The 'lower forms' are well illustrated by those described as 'mildew' and the 'higher types' by 'mushrooms.' In either case the presence of mildew acts with rapid and very destructive effect on whatever material is affected by it, but its further progress may be checked by adopting certain remedies and precautions, provided the necessary steps are taken at an early stage of its development.

Textile fibres of vegetable origin, as cotton linen, jute and hemp are more readily attacked by mildew than are the fibres of animal origin, as the numerous varieties of wool, kindred fibres, silk and others.

Cotton is much more susceptible than other species of vegetable fibres to fertilization and development of mould and mildew germs.

Mildew stains may be black, greenish, yellow, reddish brown, or orange red in colour often imparting to the material the familiar musty odour which is characteristic of mouldy goods.

Antiseptic for use in cotton goods must be colourless, odourless and cheap in proportion to their potency. Zinc chloride is an excellent antiseptic for many purposes, but it is well known that it cannot be used in all classes of goods or in conjunction with caustic soda.

As a general rule one associates mildew with heavy sizing, but it is not heavily sized goods only with which the trouble arises. It is true that heavy sizing lends itself more to risks than pure sizing,

because in the former it is necessary to use a large proportion of moisture-absorbing substances, such as chloride of magnesium and chloride of calcium in the size in order to ensure good weaving, whereas these substances are not, or should not be used in pure sizing. Then again, in the other class of sizing the yarns are well dried after they leave the size, whereas heavily sized yarns must be left with a good deal of moisture in them, otherwise weaving would be impossible. In order to counteract the tendency of the yarn to mildew whilst in the weaving shed and afterwards, some preservative, such as, chloride of zinc is used in the size.

If the Yarns are Sized too Damp.

But even in the presence of chloride of zinc mildew will develop if the yarns are sized too damp, or the chloride of zinc is not present in sufficient proportion. In the latter case mildew may develop if the goods are packed too damp in a hot country like India and stored in a damp place without sufficient light and ventilation, although they might show no signs of mildew growth at the time of packing. It appears that there is a right condition of dampness required for the growth of the mildew fungus, because goods which are wet do not mildew. This may be accounted for by the fact that one can have too much moisture to allow growth, just as a plant in a pot will die if it be watered too much. From all this it will be seen that it is necessary not only to employ a powerful preservative like chloride of zinc in heavy sizing, but the sizing must be carried out with very great care, so as to leave enough moisture in the yarn for good weaving, but not sufficient to allow mildew to grow and develop on the cloth afterwards. On the other hand, yarns which are pure sized must be well dried, without being over-dried, otherwise mildew is almost certain to develop in the weaving shed as the weaver's beam weaves out. This is where the art of sizer comes in and his knowldge can be gained only by experience.

Mildew may arise from some local cause which has nothing to do with the actual process of sizing, and yet is due to excessive moisture.

The subject of mildew is one of the most baffling problems the cotton industry has to face. It is a problem as old as the industry itself.

Basis of Size Mixing.

Description.	10 to 15%	20 to 30%	40 to 50%	60 to 80%	100%	150%	
Size of Beck	4′×4′×4′	4′×4′×4′	4′×4′×4′	4′×4′×4′	4′×4′×4′	4′×4′×4′	
Water ....Gals.	288	288	260	240	212	200	
Wheat Flour lbs. / Starch ....lbs.	288	188	410	250	220	220	
China Clay ....lbs.	....	280	350	580	750	950	Best quality.
Tallow ....lbs / Oil ....lbs.	42	48	85	100 to 150	130 to 160	180 to 240	Mutton or Beef.
C. Soda at 70° Tw.	1 quart	....	....	....	....	....	
Ch. of Magnesium lbs	....	50	100	140 to 170	150 to200	220 to 250	Solid
Ch. of Magnesium lbs.	....		160	200 to 240	240 to 280	300 to 350	at 58°Tw.
Ch. of Zinc ......lbs.	....	22	28	28	30	32	Solid
Ch. of Zinc ......lbs.	....	40	50	50	60	70	at 102° Tw

Note;—"WATER"—May be increased or reduced according to percentage of size to be put on.

"Flour and Starch."—Can be combined or Substituted at discretion or as circumstances permit with regard to cost.

"Clay."—may be increased or reduced according to percentage of size to be put on, feel and body of cloth.

Tallow and oil.—Can be combined or substituted at discretion or as circumstances permit with regard to cost etc.

Chlorides of Zinc and Magnesium.—May be increased or reduced according to humidity in the Shed, Season of the year etc. Chloride of zinc on the top side in the case of heavy size is a help in getting weight.

Epsom or Glauber Salts.—May be used to get a boardy feel or as an additional weight giving ingredients.

Basis of Size Mixing.

"Per 100 Gallons of Water."

Counts.	LIGHT Reed and Pick		MEDIUM Reed and Pick		HEAVY Reed and Pick		Remarks.
	Starch lb.	Softener lb.	Starch lb.	Softener lb.	Starch lb.	Softener lb.	
10s to 25s	40	5	45	6	50	6	Other ingredients such as
25s to 30s	30	4	35	5	40	5	chemicals etc. should be
30s to 40s	35	4	40	5	50	6	used at discretion or as
40s to 60s	45	5	50	5	65	7	circumstances demand.
60s to 80s	50	6	65	7	80	10	
80s to 100s	65	7	80	10	90	12	

Important Notes.

The reader should not be surprised if he indulges in other folks mixings which were intended for a weaving shed that is perhaps quiėt contrary in circumstances to a shed under his management without applying his common sense, knowledge and experience should he get into a mess or trouble. Because what is good in one place may not be quite good in another place. Therefore it will be better for him not to put his finger in another man's pie.

Increase or reduce ingredients for consistency or percentages, if necessary. Careful observations are absolutely necessary before making any change. Also watch the quality of water that is put in a mixing and the condensation of steam both in the size becks and sow boxes. Steam traps is absolutely necessary to be used in the sizing department is situated at a distance from the boilers wherever necessary otherwise condensation of steam cannot help but find its way somewhere.

Add nothing to the mixing no matter who swears by it unless you have an experience of it or the composition is made known to you.

Judge your water or the contents of the finishing beck by the height of the agitators. Too much reckoning in gallons might put you off or muddle you.

If good results are to be aimed at the quality of the ingredients must be as near as possible to the best.

The quantities of ingredients used in each mixing whether by weight or measure must strictly be accurate for each mixing.

It is very essential to watch the steam pressure when the size is being prepared time taken to prepare a mixing, the consistency of size, twaddle, and the weight per gallon of prepared size must be noted down for each new mixing and periodically for old mixings. The cost of a mixing is extremely important.

Size Mixings.*

10 to 15 Per cent.

(1) 24s warp, 52 Reed, 52 Pick (to the inch)—Grey Dobby or Plain cloth.

Pearl Sago	=238 lbs =74.28%
Farina	= 50 lbs =15.66%
Tallow	= 30 lbs = 9.36%
C. Soda (Solid)	= 6 ozs = 0.10%
Aktivin S.	= 2 lbs = 0.60%
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′
Weight of prepared Size	= 9½ lbs. per gallon at 160° Fah.

Mode of Preparation :—

(1) Take water =28″ app.
(2) Add. C. Soda.
(3) Agitate for a Short time.
(4) Add Sago (after steeping overnight)
(5) Boil to 160° Fah.
(6) Mix Farina in cold water and then add slowly to the mixing. Preferably after the mixing is half boiled.
(7) Add Aktivin S. mixed in a little cold water.
(8) Stop boiling.

10 to 15 per cent.

(2) 24s Warp, 56 Reed, 52 Pick, (to the inch)—Grey Dobby or Plain cloth.

Sago Flour	=100 lbs.
Pearl Sago	=100 lbs.
Farina	= 88 lbs.
Glycerine	= 5 lbs.
T. Red oil	= 10 lbs.
Tallow	= 15 lbs.

*It does not mean that the mixings that are given here can only be used for the class of goods mentioned against each of them. It can be used for any other goods as well, such as, L. Cloth, Shirting Sheeting etc, and also for any counts of yarn or Reed or Pick.

10 to 15%—continued

C. Soda 70° Tw.	= 1 quart.
Water	=288 Gallons.
Consistency of Size	= 5 to 6° Tw. before boiling.
Boil to	=140° to 150° Fah.
Weight of Size when ready at 160° Fah.	=9½ lbs.

10 to 15 per cent.

(3) 20s Warp, 52 Reed, 48 Picks (to the inch)—Grey Dobby or Plain cloth.

Sago Flour	=140 lbs.
Farina	=140 lbs.
Tallow	= 25 lbs.
Caustic Soda (Solid)	= 8 ozs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′

Boil for three-quarters of an hour.

10 to 15 per cent.

(4) 30s Warp, 60 Reed, 56 Picks (to the inch)—Grey Dobby or Plain cloth.

Sago Flour	=150 lbs.
Maize Starch	= 38 lbs.
Farina	=100 lbs.
Spermaceti wax	= 1 lb.
White wax	= 1 lb.
Beeswax	= 1 lb.
Olive-oil Soap	= 1 lb.
Gum tragacanth	= 1 lb.
China clay	= 10 lb.
Tallow	= 25 lb.
Caustic Soda (Solid)	= 8 ozs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′

Boil for three quarters of an hour.

10 to 15 per cent.

(5) 36s Warp, 72 Reed, 60 Picks (to the inch)—Grey Dobby or Plain cloth.

Wheat Flour } Steeped	= 68 lbs.
Ch. of Zinc } Steeped	= 5 lbs.
Sago Flour	= 80 lbs.
Farina	= 60 lbs.
Penetrose I.	= 80 lbs.
China clay	= 30 lbs.
Tallow	= 30 lbs.
Water	=288 lbs.
Size of Beck	=4′ × 4′ × 4′

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10 to 15 per cent.

(6) 40s Warp, 68 Reed, 60 Pick (to the inch)—Plain weave cloth.

Sago Flour	=144 lbs.
Farina	=144 lbs.
China clay	= 20 lbs.
Tallow	= 30 lbs.
Spermaceti Wax	= 2 lb.
Paraffin Wax	= 1 lb.
Windsor soap	= 3 lb.
Gum tragacanth	= 2 lb.
Caustic Soda (Solid)	= 6 ozs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′

Boil for three-quarters of an hour.

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10 to 15 per cent.

(7) 30s. Warp, 56 Reed, 52 Picks, (to the inch)—Plain Twill 3 × 1.

Flour (Wheat)	=138 lbs.
Ch. of Zinc	= 10 lbs.
Farina	= 50 lbs.
Maize Starch	= 50 lbs.
Sago Flour	= 50 lbs.
Tallow	= 30 lbs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′

10 to 15 per cent.

(8) Up to 100s Warp, 84 Reed, 72 Pick (to the inch)—Plain Weave.

Penetrose I.	=100 lbs.
Farina	=108 lbs.
Sago Flour	= 80 lbs.
Tallow	= 18 lbs.
Glycerine	= 10 lbs.
Water	=288 Gallons.
Size of Beak	=4′ × 4′ × 4′

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10 to 15 per cent.

(9) 30s Warp, 56 Reed 56 Pick (to the inch)—For unbleached goods).

Pearl Sago	=150 lbs. (Steeped overnight)
Farina	= 70 lbs.
Maize Starch	= 68 lbs.
Turkey Red oil	= 10 lbs.
Japan wax	= 5 lb.
Tallow	= 10 lb.
Glycerine	= 10 lb.
Caustic Soda (Solid)	= 8 ozs.
Water	=288 Gallons
Size of Beck	=4′ × 4′ × 4′
Boil to	=160° Fah.

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10 to 15 Per cent.

(10) 30s Warp, 60 Reed, 56 Pick (to the inch) For unbleached goods.

Pearl Sago	=100 lbs. (Steeped overnight)
Penetrose I.	= 88 lbs.
Farina	=100 lbs.
Glucose	= 5 lb.
Gum tragon	= 5 lb.
Tallow	= 15 lb.

10 to 15%—continued.

Glycerine	= 10 lb.
Pine oil	= 2 lb.
C. Soda (Solid)	= 6 ozs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′
Boil to	=160° Fah.

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20 to 30 Per cent.

(11) 30s Warp, 52 Reed, 48 Picks (to the inch)—Plain weave cloth.

Wheat Flour	=188 lbs.
Ch. of Zinc	= 15 lbs.
Farina	= 25 lbs.
Sago Flour	=138 lbs.
China clay	=100 lbs.
Spermaceti wax	= 4 lbs.
Paraffin Wax	= 4 lbs.
Gum Tragacanth	= 5 lbs.
Tallow	= 50 lbs.
Ch. of Magnesium (Solid)	= 50 lbs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′
Weight of prepared Size to the Gallon	=10½ lbs. at 160°Fah.

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20 to 30 per cent.

(12) A continental mixing for Fast Coloured Goods.

Medium counts of yarn and Medium Reed and Picks.

Sago Flour	=160 lbs.
Farina	=196 lbs.
Amylose D.	= 20 lbs.
Ramasit I.	= 10 lbs.
Nekol. BXDry	= 10 lbs.
Tallosan S.	= 10 lbs.
Tallow	= 40 lbs.
Preventol	= 5 lbs.
Glycerine	= 10 lbs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′

Mix the ingredients (Starches) in cold water and then pour through a sieve into the finishing vat, add all the other ingredients. Heat up to the boil after that keep boiling for about 10 minutes. Reduce Steam.

Ramasit I. is dissolved in water of a temperature of 100° F. and kept ready. When the size is cooled down to 140° to 155° Fah. then it must be added to it through a sieve.

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20 to 30 per cent.

(13) 30s Warp, 60 Reed, 60 Pick, (to the inch)—Plain or Fancy Border Dhoty or Saree.

Wheat Flour	=150 lbs.
Wheat Starch	= 50 lbs.
Ch. of Zinc	= 12 lbs.
Pearl Sago	=100 lbs.
Penetrose II.	= 76 lbs.
China Clay (best quality)	=280 lbs.
Tallow	= 30 lbs.
Glucose	= 10 lbs.
T. Red oil	= 10 lbs.
Gum Tragon	= 10 lbs.
Spermaceti	= 5 lbs.
Japan Wax	= 5 lb.
Ch. of Magnesium (Solid)	= 50 lbs.
Soda ash	= 2 lbs. (to break up china clay)
Aktivin S.	= 2 lb.
Water	=288 Gallons
Size of black	=4′ × 4′ × 4′

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20 to 30 per cent.

(14) 30s Warp, 56 Reed, 56 Pick, (to the inch)—Plain or Fancy goods.

Sago Flour (best quality)	=300 lbs.
Penetrose II.	= 41 lbs.
Rice Starch (best quality)	= 25 lbs.
China clay (best quality)	=120 lbs. (finepowder)
Tallow	= 50 lbs.
Glycerine (best quality)	= 5 lbs.
Glucose.	= 5 lbs.
Caustic Soda (Solid)	= 8 ozs.
Water	=288 Gallons.
Size of beck	=4′ × 4′ × 4′

20 to 30 Per cent.

(15) 22s Warp, 48 Reed, 44 Picks (to the inch), Plain or Fancy, Dhoty or Saree.

Wheat Flour.	=250 lbs.
Maize Starch	=126 lbs.
Ch. of Zinc	= 18 lbs. } Solid.
Ch. of Magnesium	= 50 lbs. } Solid.
Tallow	= 60 lbs.
Water	=288 Gallons.
Size of Beck	=4′ × 4′ × 4′

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40 to 50 Per cent.

(16) 20s Warp, 30s Weft, 56 Reed, 48 Pick. (to the inch) Shirting

Wheat Flour } Steeped	=300 lbs.
Ch. of Zinc } Steeped	=24 lbs × 2 lbs.(Solid)
Maize Starch	= 80 lbs.
Soluble Starch.	= 30 lbs.
Tallow	= 60 lbs.
T. Red oil.	= 15 lbs.
Glycerin	= 5 lbs.
Aktivin S.	= 2 lbs.
Ch. of Magnesium	=100 lbs. Solid
Blue	at discretion.
Water	=260 Gallons.
Weight of Prepared size	= 12 lbs. at 160° Fah.
Size of Beck	=4′ × 4′ × 4′

Mode of Preparation.

(1) Take one mark of flour =300 lbs.
(2) Add 22″ of water.
(3) Put Maize starch and Soluble Starch in the clay pan mixed in $14\frac{1}{2}$″ of cold water =(48 Gallons)
(4) Bring down or mix starch with flour.
(5) Agitate for at least 2 hours.
(6) Add 2 lbs. of chloride of zinc.
(7) Agitate for half an hour.
(8) Boil to 160° Fah.
(9) Add tallow and oil.
(10) Add Aktivin S. and continue boiling for 10 minutes.
(11) Add Blue.
(12) Stop steam and use.

40 to 50 per cent.

(17) 20s Warp. 48 Reed 44 Picks (to the inch)—Boardy feel—grey cloth.

Wheat Flour	Steeped	=300
Ch. of Zinc		= 24 (Solid)+2 lbs.
C. P. Warp Sizing Starch		= 90
Soluble Starch		= 20
China Clay (best quality)		=350
Epsom Salt.		= 30
Ch. of Magnesium		=100
Tallow		= 80
T. Red oil		= 5
Blue		= at discretion
Water		=260 Gallons.
Size of Beck		$=4' \times 4' \times 4'$

Mode of Preparation.

(1) Boil clay in the clay pan with $14\frac{1}{2}''$ water=48 Gallons. add part of oil and tallow. add the whole quantity of Epsom Salt and ch. of Magnesium.

(2) Boil the contents of the clay pan at least for 6 hours and let it cool down.

(3) Admit 10″ water in the finishing Beck.

(4) Add one mark of Flour=300 lbs+24 lbs. of Zinc and Starches=110 lbs.

(5) Let down the contents of the clay pan into the finishing beck.

(6) Let the whole contents of the Finishing Beck agitate for at least 2 hours.

(7) Start Boiling.

(8) Add the remaining part of oil and tallow.

(9) Boil to 160° Fah.

(10) Add 2 lbs of Zinc.

(11) Add Blue.

(12) Stop steam and use.

Note ;—Increase or decrease salt according to feel and body required. also increase or decrease water as it may be found necessary.

40 to 50 per cent.

(18) For Fast Coloured Goods. Medium counts of yarn and medium counts of Reed.

Sago Flour	=234 lbs.
Farina	=136 lbs.
Amylose D	= 40 lbs.
China clay	=400 lbs.
Ramasit I.	= 16 lbs.
Nekol Bx dry	= 16 lbs.
Tallosan S.	= 30 lbs.
Tallow	= 50 lbs.
Shirlan Powder	= 0.03 % per 100 lbs. of Sized yarn
Ch. of Magnesium	=120 lbs. (Solid)
Blue	=at discretion.
Water	=260 Gallons.
Size of beck	=4′ × 4′ × 4′

Follow the mode of preparation as given for No. 12 mixing.

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40 to 50 per cent. Plain Drill cloth.

(19) Maize Starch	=286 lbs.
Sago Flour	= 50 lbs.
Farina	= 84 lbs.
China Clay	=475 lbs.
Chloride of Zinc	= 10 lbs.
Chloride of Magnesium	=120 lbs (Solid)
Blue	= as required.
Water	260 Gallons.
Size of beck	=4′ × 4′ × 4′

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40 to 50 Per cent. For Dhoties and Sarees.

(2) Wheat Flour	=350 lbs.
Amylose	= 40 lbs.
Penetrose III.	= 20 lbs.
China Clay	=350 lbs.
Ramasit I.	= 5 lbs.
Nekol Bx dry	=2½ lbs.
Shirlan Paste	= 0.06 % per 100 lbs. of Sized yarn.
Tallow	= 80 lbs.
Ch. of Magnesium	=120 lbs. (Solid)
Water	=260 Gallons.
Blue	=as desired
Size of Beck	=4′ × 4′ × 4′

Hints on proportions to be used of the following ingredients.

Ramasit I = 2 to 4 lbs for every 100 Gallons of size for giving lustre to the cloth.

Amylose = 3 to 6 lbs. of Flour to 1 lb. of Amylose, which needs no steeping or fermenting but added to the steeped flour in the mixing ready for boiling. It will give very good body and prevent chaffing.

Nekol Bx dry = 1 to 3 lbs to 100 Gallons of Size. Should be mixed in boiling water and added to the finished size when ready but after adding it continue the boil for further 10 minutes.

Shirlan = prevents mildew, and may be used in lieu of zinc chloride Paste = ·06 per cent Powder = ·03 per cent per 100 lbs of sized yarn.

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(21) 60 to 80 Per cent.

Wheat Starch	= 40 lbs.
Sago (Pearl)	= 100 lbs.
Farina	= 40 lbs.
Penetrose III.	= 50 lbs.
China Clay (best quality)	= 580 lbs.
Epsom salt	= 25 lbs.
Glycerin	= 2 lbs.
T. Red oil	= 3 lbs.
Tallow	= 80 lbs.
Gum tragon	= 5 lbs.
Spermaceti wax	= 5 lbs.
Paraffin wax	= 5 lbs.
Chloride of Zinc	= 28 lbs.
Chloride of Magnesium	= 140 lbs. (Solid)
Blue	= as desired.
Water	= 244 Gallons.
Size of Beck	= 4′ × 4′ × 4′
Weight of prepared size	= 15 lbs per gallon at 160° Fah.

(22) 60 to 80 Per cent.

Wheat Flour	=140 lbs.
C. P. Warp Sizing Starch	=110 lbs.
China clay	=580 lbs.
Epsom Salt	= 25 lbs.
Tallow	= 90 lbs.
Chloride of Zinc	= 28 lbs. Solid
Chloride of Magnesium	=140 lbs ,,
Blue	= at discretion.
Water	=244 Gallons.
Size of Beck	= 4′ × 4′ × 4′

(23) 100 Per cent.

Wheat Flour	=220 lbs.
Ch. of Zinc	= 1 30 lbs. (Solid)
Tallow	=160 lbs.
China clay	=750 lbs.
Epsom Salt	= 70 lbs.
Chloride of Magnesium	=175 lbs. (Solid)
Blue	= as required.
Water	=212 Gallons.
Size of Beck	= 4′ × 4′ × 4′

(24) 125 Per cent.

Wheat Flour	=220 lbs.
Ch. of Zinc	= 30 lbs. (Solid)
China clay	=850 lbs.
Glauber Salt	=180 lbs.
Paraffin wax	= 15 lbs.
Ch. of Magnesium	=190 lbs. (Solid)
Castor oil (best)	=200 lbs.
Blue	= as required.
Water	=212 Gallons.
Size of Beck	= 4′ × 4′ × 4′

(25) 150 Per cent.

Wheat Flour	= 220 lbs.
Ch. of Zinc	= 32 lbs. (Solid)
China clay	=950 lbs.
Epsom Salt	= 90 lbs.
Chloride of Magnesium	=220 lbs. (Solid)
Tallow	=200 lbs.
Blue	= as required.
Water	=200 gallons.
Size of Beck	= 4′ × 4′ × 4′

For 200 and more per cent reduce water and increase clay.

Rayon Mixing—"Lustre yarn."

(26) Size Mixing for Rayon or artificia' Silk yarn.

Irish Moss	= 98 oz.
White wax (Japan) a mixture of 75% Tallow and 25% wax.	= 34 oz
White jelatine	= 34 oz. (Best quality)
White Dextrin	= 52 oz.
Soluble Starch	= 52 oz.
Olive or Turkey red oil	=1114 c.c =2.45 lbs. (1000 c.c. =0.22 Gallon =2.2lb).
Water	= 52 Gallons.
Ready prepared size	= 40 Gallons.

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(27) Rayon Mixing—"Dull Lustre yarn."

Irish Moss	= 92 oz.
White wax (Japan)	= 30 oz.
White jelatine	= 30 oz. (Best quality)
White Dextrin	= 48 oz.
Soluble Starch	= 48 oz.
Olive or Turkey red oil	$=2\frac{1}{4}$ lb.
Water	= 48 Gallons.
Ready size.	= 37 Gallons.

Mode of Preparation for No. 26 and 27.

(1) Take water.
(2) Boil to 85° Fah.
(3) Add Irish Moss after steeping in water to reduce it to a solution or soften it.
(4) Add jelatine after dissolving in hot water.
(5) Add wax.
(6) Boil to 180°
(7) Add Dextrim.
(8) Reduce Boiling Slowly to 70°.
(9) Strain through a fine cloth or gauze.
(10) Add Olive or Turkey red oil. Stir or agitate briskly until oil is well mixed up.
(11) Allow to cool and then use it up, generally the next day or if prepared in the morning use after it has cooled down in the evening.

(28) Rayon single thread size Mixing.

Amisol No. 6	= 3.5 lbs.
Pearl starch	= 5.0 lbs.
Cocoanut oil	= 1.0 lbs.
Water	=12.5 Gallons.

Mode of Preparation ;—Keep 10 gallons of water for boiling and suspend Amisol No. 6 and Pearl starch in 2.5 gallons of water to make a lump free suspension. Add this suspension to the boiling water and stir uniformly. when the starch gelatinizes completely add the oil and boil for 5 minutes, cool and strain if required and the solution is ready for use.

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(29) Size Mixing for Sewing Thread.

For " Fine thread."

Farina	= 11 lbs.
China clay	= 9 lbs.
White wax	= 2 lb.
Tallow	= $1\frac{1}{2}$ lb.
Soap	= 9 ozs.
Water	= 26 Gallons.

Boil to a paste.

For " Coarse Twine."

Farina	= 24 lbs.
Tallow	= $1\frac{1}{2}$ lbs.
White wax	= 2 ozs. (be added for gloss finish)
Water	= 28 Gallons.

Boil to a paste.

In place of tallow soft soap or common glycerin may be added.

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(30) Size Mixing for Jute yarn.

Farina	= 50 lbs.
White Sago Flour	= 60 lbs.
China clay	= 10 lbs.
Turkey Red oil	= 3 lbs.
Mutton Tallow	= 6 lbs.
Chloride of Zinc	= 2 lbs.
Water	=280 Gallons.
Size of Beck	= $4' \times 4' \times 4'$

CHAPTER XXXIII.

DRAWING-IN.

Drawing-in is solely the system used in India. All drawing-in is done by drawers and reachers combined, though the former is paid by piece work and the latter either paid a fixed wage or receives half of what the drawers receive in rate.

The weaver's beam, as made at the sizing frame, contains on an average of 21's twist 1088 yards, provided the diameter of the flanges is 17 inches and the barrel $4\frac{1}{2}$ inches. The length varies as the count of yarn, number of ends, and the diameter of the flanges.

The beam is not yet ready for the loom, as the healds and the reeds have to be attached to it. Each end must be drawn through an eye of one of the healds and through a dent in the reed. In this case the operation is performed by a drawer-in, who with reed hooks at one side, that is in front of the healds and reed draws the ends through, which are presented to him by a reacher at the opposite side. The order in which the ends are drawn through the healds is most important although for plain and simple fancy work, one system is generally adopted for fancy cloths; the draft varies greatly and regulates to a great extent the kind of figure produced on the cloth.

Healds.

The selection of suitable healds and reeds for weaving high grade cotton fabrics is a problem.

There are three styles of loom used in the manufacturing process (*a*) tappet looms; (*b*) dobby looms; (*c*) jacquard looms. When the tappet and dobby looms are used the warp threads are controlled by means of healds arranged upon heald staves in an expanded form, whilst in the jacquard loom, harness is substituted for healds, and is permanently connected to the jacquard machine. In the tappet and dobby looms the heald shafts are connected to the shedding levers or jacks by some simple means and can be easily detached after weaving the warp yarn from the yarn beam. On that account the heald sets are changed very often, and in some instances the same loom is required to weave a fabric very fine in texture immediately after weaving a heavy or coarse fabric. Since the healds are the means of control for the warp threads during the process of weaving

and each heald is in close contact with the warp threads in the adjacent healds, it is obvious that in sets where the number of healds per inch are high, and the warp yarn to be woven is fine, every care must be taken in the selection of healds, otherwise many warp breakages and cloth defects will be caused.

Healds for the ordinary class of work are usually of 15/40's and 10" deep for plain cloth. A few mills knit their own healds and make their own reeds. But this has not proved a success yet owing to the sizing and varnishing processes not suiting the extreme changes of weather. A few mills import healds knitted to pattern required which is certainly a very expensive method to adopt.

These healds and reeds are required in the loom, being of great importance with regard to the proper inter-lacing and guidance of the ends and picks. The healds are of cotton or worsted, and are used in making the shed for the passage of the shuttle, also to control the warp threads when tappet or dobby shedding motions are used. The usual form is a loop, tied through a quarter inch eye through which the warp thread is drawn. The healds are knitted in a special machine, and when finished show the loops ten or more inches deep, connected with a braid running along the top and bottom. The eyes are closely or sparely arranged according to the counts of reed for which the healds are intended. Staves are inserted in the top and bottom loops, and a set of healds consisting of four or more staves according to the weave or design, are arranged one behind the other.

The counts of healds indicate the number of heald eyes on 1 inch across all the healds in a set. Thus 48's count having 4 shafts or staves in a set would have 12 eyes per inch per shaft and if the counts of healds are 80 and the set is composed of 8 shafts then there will be ten eyes per inch per shaft and would be drawn in the following order :—

			4
	3		
		2	
1			

to allow healds 1 and 2 to work together and healds 3 and 4 to work together.

When four Staves are used the first two are tied up to the front strap of the top roller and to the front lamb rod, whilst the back two are tied up to the back strap of the top roller, on a slightly larger diameter pulley, and the back lamb rod.

The strain due to the lifting of the healds will not be the same on each stave. The back stave, being farthest away from the fell of the cloth, must of necessity lift higher than the front stave in order to make an even shed for the shuttle, and therefore the back stave will tend to wear out sooner than the others.

Four heald shafts are used in plain sets to prevent over crowding. A three-shaft twill drawn to a 60's reed would require 20 healds on each shaft per inch. When the counts are high it is best to use six shafts for this style of twill and draw the ends 1.3.5.2.4. Thus by working shafts 1 and 2, 3 and 5 and 6 together the weave will be the same as with three shafts. A four-shaft twill would require the same counts as a plain set and would be drawn 1.3.2.4 to allow the healds to be used for a plain weave if required. In making the lifting plan, the working of the staves 2 and 3 would be reversed, i.e., heald 2 working the third end and heald 3 working the second end in each repeat.

A five-shaft sateen 60's reed would require 12 eyes per inch on each shaft and drafted 1, 2, 3, 4, 5, whilst an eight-shaft sateen 104's reed would require 13 eyes per inch on each shaft.

Loom Drafting.—All warp threads or ends that weave the same are placed on the same shaft.

There are four styles of drafts as applied to healds namely :—

"*Straight Draft.*"—In which the threads are drawn through the healds in consecutive order from front to rear, either to the right or left. Used for regular weaves. The repeat of ends in a woven design with a straight draft cannot exceed the number of healds employed.

"*Broken Draft.*"—In which the consecutive order is broken, in order to produce some special effect as 2×2 stitch in a 2×2 twill. Or to reduce the fineness of healds as in plains.

"*Centre or Point Draft.*"—This is the straight draft reversed giving a turn-over effect. Used for diamond, and reversed twill effects. The repeat of ends in the woven design will be equal to twice the number of healds employed minus two.

"*Mixed Draft.*"—In which all the previous types may be arranged as desired. Used for designs containing several styles of weaves The repeat of ends in a woven design may be any number, irrespective of number of healds used.

The Operation of Drawing-in.

The warp beam and healds are suspended in a vertical stand which is adopted suitably for the purpose of supporting the warp beam in an elevated position to permit of the warp threads drooping immediately behind the healds which are secured firmly in the same relative positions that they will occupy when they are gaited up in the loom. The warp threads are ready for the operation of drawing-in, which requires to be performed with great care to avoid what are termed "mis-drafts" that would cause wrong interlacings of warp and weft, and thus produce faults in the cloth and its design during the weaving. It is usual to commence drawing-in on the left-hand side of the healds when facing it. The reacher with the right-hand then proceeds to select the warp threads from a bunch held in the left-hand and delivers them in consecutive rotation to a reed-hook which is inserted through successive eyes of the healds by the drawer-in who draws the warp threads forward through those eyes in a prescribed order indicated by the drafting plan. The reacher is assisted in selecting warp threads to deliver them in their proper rotation in the case of a striped warp or warp with various colours to the reed-hook of the drawer-in by a lease thus × which is the only perfect form of lease, inasmuch as it disposes the warp threads alternately into an odd and an even series, constituting two distinct sheets of threads that cross each other in such a manner that they may be selected from the lease only in their proper rotation. The drawer-in usually employs a double hook, consisting of two separate reed hooks of different lengths inserted in the same handle about half an inch apart, and parallel with each other, whereby two warp threads may be drawn through separate heald eyes simultaneously, and thus increase the speed of drawing-in.

Order of Drafting.

After the warp threads are drawn through the heald's eyes they are passed by the drawer-in immediately under a special form of a broad thin hook (=dent hook) usually made from discarded shuttle, and inserted from above, between successive dents of the reed, but withdrawn from below, thereby drawing the warp threads also through the reed. Now reverting to the simple order of drafting such as that employed for plain weave, the first thread of warp is passed through the first loop of the first heald, the second thread is passed through the first loop of the third heald, the third through the first loop of the second heald, the fourth through the first loop of the fourth heald. The fifth is passed through the second loop of the first, the sixth through the second loop of the third heald, and

so on to the end. At times more than one end is drawn through one eye of a heald. Plain could be woven by two staves, but four are almost always employed. It is the same case with the reed if one or more ends are drawn through each dent. Generally two ends are drawn through each dent. The reed is constructed of a series of long first steel ribs or 'dents' extending between two rods of wood which are placed about 4 inches apart and are known as ribs. It resembles a comb the teeth of which are fixed at each side by two long rods. These teeth or dents are placed so close to each other that from sixteen to thirty six or more are set along per inch of the rods. The total length of the reed coinciding with the breadth of the cloth to be manufactured, and the number of teeth in the reed corresponding with the number of picks or warp threads required to be put in the cloth, or, in other words, the number of dents that the reed contains in an inch, determines the count of the reed. The system of numbering reeds is known as the stock-port or Manchester count. The number of dents or splits per inch in the reed with two ends in each dent is the basis of the system. If the reed has 40 dents per inch, it is called a 80's reed, because if there are two ends to be drawn per dent then there will be 80 ends per inch. The number of the reed is always the same as the ends per inch in the reed, if the ends are all two in a dent.

When ordering reeds, the following particulars should be given:–

Example :—

40's st. 12 G. 40″ × $4\frac{3}{4}$″ Blue.

This means 40's counts stock-port system. 12's gauge wire, 40″ in. long and $4\frac{3}{4}$ in. deep, blue paper on baulk.

It must be strong and durable, and also highly polished to reduce the friction on the warp threads that are in close contact with it during its traverse to and from the fell of the cloth.

When ascertaining the counts of reed from the cloth on the counter, if the cloth is woven with 52's reed it will count 56 ends to the inch after calendering and 54 in the grey or before calendering.

Reed plays an important part in the weaving, as it is used: (1) to beat up each pick of weft inserted by a shuttle (2): it helps to keep warp threads in their proper position; (3) it forms a back guide for a shuttle to run against; (4) all calculations connected with cloth depends on the reed, as it determines the fineness of the cloth.

The method of seperating the warp to form a shed is, for an example, a warp of 3000 ends be drawn on four healds each having

750 eyes and two of these healds be raised whilst the other couple is depressed, a shed of two equal parts will be formed, that is, the first and second healds have an upward motion; whilst the third and fourth have a simultaneous downward motion, which is communicated to them by an arrangement of machinery called treadles. These motions thus make every alternate thread of the warp to be pulled up by the first and the second healds, whilst the third and fourth pull down the other alternate threads and so produce what is called the "Shed" along which the thread of weft is shot by means of a shuttle.

Metallic or wire healds are also in use. The loops and eyes are of wire sliding on bars attached to the staves. The only facility, in this case, is a set of healds which may be used for different counts of reeds and it can be used for figured cloth where one or two staves are required with very few number of healds.

There are also mail eyes healds in use, that is, the eyes are of steel. It is advisable to use these healds for plain or twill (up to 6 shafts) works as it lasts much longer (about 200%) than the ordinary cotton healds.

Healds with glass eyes are used for rayon weaving.

A good heald should be smooth and glossy, and it should be made from the best combed Egyptian yarn. It should be saturated right to the core with the purest varnish. If there should be any grit at all in the varnish there is a danger that some of the grit will stick to the healds and cut the yarn during weaving. The eye should be hard and firm to resist wear. At the bottom the two threads forming a heald are separated one passing round each side, but at the top they are on the same, front and back alternately. This gives a natural angle of 45 to the position of the eye. The following counts of yarn are used in manufacturing cotton healds.

Twist	Size per cent.	Counts of heald yarn.
18s–24s	25 to 35	12/40s, 18/40s
18s–24s	40 to 60	16/50s
18s–24s	above 60	18/50s, 16/60s
26s–32s	10 to 20	12/40s, 15/40s, 16/60s
26s–32s	25 to 35	15/40s, 12/50s, 16/50s
40s–50s	10 to 20	16/50s, 16/60s, 16/70s
52s–62s	10	12/65s, 16/60s, 16/70s
82s–120s	5 to 10	16/70s, 12/90s.

It is usual to insert a coloured cord along the top knitted healds at some definite interval to facilitate counting.

Let it be clearly understood that the counts of healds are based on the number of heald eyes on four shafts, and this applies no matter how many staves are being used. For instance, 60s healds means 60 heald eyes per inch on four staves, or 15 heald eyes per inch, per stave, and likewise for any other counts.

When ordering healds the following particulars should be given:–

1. (*a*) Counts of healds.
   (*b*) Width of healds in inches.
   (*c*) Depth.
   (*d*) Ends per dent.
2. Counts of yarn to be woven and how sized.
3. Number of Shafts.
4. Draft and Denting of the Warp threads.
5. Length of top stave.
6. Length of bottom stave.

"Rules for finding the total number of healds in a set."

Counts × Width = Eyes per set.

Eyes per set ÷ number of shafts = eyes per shaft.

Taking a plain set 72's Counts, 30 in. reed width.

Healds per inch on each shaft = 18

∴ 18 × 30 = 540 Healds on each shaft.

540 × 4 = 2160 Total healds in a set of 4 healds.

Makes frequently distinguish the fineness of healds by special marks such as—

Black	= Coarse
Red	= Medium
Green	= Fine

Example ;—

72/16 × 40's × 12's, 16/60's, 2880, Red.

This means 72's counts of healds, 16 shafts in a set 40 in. long 12 in. deep 16/60's yarn 2880 (72 × 40) Eyes, medium.

When the healds have been knitted, they are divided on each stave into "tokens," a "token consisting of 20 healds" and these are usually shown on the top of each stave by a coloured thread looped

into the healds every twenty. This makes it a simple matter to count how many healds there are on each stave and by counting the tokens on the stave and measuring the length of the healds on the stave the counts can be easily determined or checked.

The Importance of Healds.

The writer is of opinion that far too little actual attention is paid to this important and expensive accessary to weaving. They should be of correct dimensions, and this applies to not only the healds, but the heald staves also. Sometimes perhaps from a mistaken view of economy, there is not sufficient depth from the top to the bottom stave. In such cases there is a danger that the warp yarn will come into contact with the staves when a shed is formed, thus rubbing and weakening the threads. If the depth between the top and bottom staves is excessive, then increased cost has been incurred without any benefit in return. Every weaving master or manager should study this point for his own looms and see that the healds are made to his specification.

The length of the heald staves across the loom are well worth consideration. The top staves may be used the full reed space width of the loom, but the bottom staves should always be two inches shorter, that is one inch at each side of the loom, to allow for the movement of the crank and crank arm without the risk of constant banging against the staves. This happens far too often, and is not conducive to good weaving especially if fine and delicate yarns are being woven.

The method of attaching the healds to the staves is very important and care must be taken about it. If a heald is so hung on the stave that a full eye is presented to the thread, then there will be friction of threads against the outsides of the healds when a crossing is made to form a new shed. On the other hand, if the heald eye is not so set that it is reasonably straight for the warp thread to pass through, then not only will there be friction of the thread in the eye, but it will be difficult for the drawer-in or operative to draw the threads through the eyes. To so set the healds that these difficulties are overcome, they are attached to the staves so as to give the healds eye an angle of 45 degrees with the warp, so that the thread may be easily drawn-in, and more room is allowed for those warp thread's passing through other heald eyes and between the healds on the other staves. To get this desirable result the two threads of cords forming the healds are taken, for the first heald" in front " of the

top stave, but the two cords are split at the bottom so that one cord passes in front of the bottom stave and one behind. The next heald is made with the two cords passing "behind" the top stave, and split as before for the bottom stave.

Storage and Care of Healds.

In the drawing-in department it is essential that everything should be done systematically. The healds may be stored either on the rafters of the roof or, in racks standing on the floor. The latter method is much preferable.

Economy in the use of Healds.

It is false economy to endeavour to use a set of healds when they have begun to show signs of deterioration, but at the same time it is possible to save and use hundreds of staves, even in one or two staves in the set are really worn out.

"DRAWING-IN DEPARTMENT"

No. or Gauge of Wire for Reeds.

Counts of Reed.	Depth of Reed.	Gauge of Wire	Counts of Reed.	Depth of Reed.	Gauge of Wire.	Counts of Reed.	Depth of Reed.	Gauge of Wire.
30's	3½	18.75	46's	3½	28.00	56's	3½	35.00
32's	3½	20.00	48's	3½	29.00	58's	3½	36.00
36's	3½	22.00	50's	3½	31.00	60's	3½	37.00
40's	3½	25.00	52's	3½	32.00	64's	3½	40.00
44's	3½	27.00	54's	3½	33.00	72's	3½	45.00

"KNITTING PLAN"

	Dents	SHAFTS.																			
No. of Pattern	...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	½			1						1											
Reed 56 ...	½				1						1										
	½			1								1									
	½				1								1			Three times.					
Width 36"	½			1										1							
	½				1										1						
	1			1	1	Three times.															
Twist 18's/40's	1			1	1																
	1					1	1	Twice													
	1			1	1								Three times.								
Depth 12" ...	1							1	1	Twice											
	1			1	1																
	1					1	1	Twice.													
	1			1	1	Three times.															
No of Patterns in a set 15.	½	1	1	Eight times																	
	1			1	1	Twice															
	1			1	1																
	1					1	1	Twice.					Three times.								
	1			1	1																
	1							1	1	Twice											
	1			1	1																
	1					1	1	Twice.													
	1			1	1	Four times.															
Total Dents.	67																				
Remarks:—	10720	536	536	2345	2345	1072	1072	804	804	201	201	201	201	201	201						Total Healds

Weaving Master, *Manager,*

Duties of a Drawer-in.

The duties of a drawer-in are; (1) for the correct order in which the warp threads should be drawn through healds and reed as presented to him by a reacher for fancy work a drawing-in draft is supplied to him for his guidance and from which he must select the right counts of healds and arrange their order of staves previous to commencing to draw-in; (2) he must see that the total number of warp threads in the weaver's beam comes out to the calculated width in healds and reed. This can be obtained by dividing the total number of ends by the number of ends per inch in the reed; (3) he must see that the healds are in a good condition, and that the most suitable healds are used for the work they have to do so as regards the fineness or otherwise of the heald yarn; (4) the reed should also be carefully examined to see that the surface of the dents is smooth and that no loose dents appear or project, also, that the surface of the dents are not strained and resty, and defective healds or reed should be set aside for repairs; (5) he must see that the warp ends are not drawn too narrow in the healds and wide in the reed, nor the warp is drawn too wide at the healds and narrow at the reed.

For good working it is best to have the width about half an inch wide at the healds than the reed.

Casting out.

Casting-out is resorted to when there are more heald eyes per inch than ends per inch. In other words, the counts of healds are finer than what is required. For an example, counts of healds required for a set of 4 shafts are 60's counts. Healds available are of 68's counts.

$\therefore$ 68's-60's =8 eyes to cast out per inch or 2 eyes per inch per shaft.

To avoid confusion, the casting-out should be done in a regular manner, if not, the weaver may take the ends through the wrong healds and a wrong draft would result.

If the castout is not complete in rows per inch, such intervals should be found that will give an even distribution. The strain that will be placed upon the warp ends near the castout must be considered. If too many healds are cast out together bad weaving will result.

When a drawer-in is compelled to use a set of healds for a certain weaver's beam that requires a specially knitted healds, he must be careful not to cast out too many of healds lest it will come out too wide at the healds, if he does *vice versa*, the warp will come too narrow at the healds.

Jacquards Harness.

When Weaving with Jacquards the dropping of mails, termed "Casting out" is a regular feature of the day's work, a Jacquard harness being so costly that it could not possibly be changed for all counts of reeds, hence it must be used for a large number of warps if it is to be economical. The harness is built fine enough to provide sufficient mails for the finest reed it is expected to be used. The "Casting out" means the leaving out, for that warp to be woven, of short rows of the Jacquard machine. Taking for an example, a 200s machine, although the system applies to any size of Jacquard there are 26 rows of hooks, with 4 hooks in a row. Having 204 hooks or mail eyes, if a straight draft the 4 over the two hundred being for odd purposes as, say, the selvedge weave, leaving 25 rows for pattern production.

Barber Tying Machine.

In order to facilitate the operation of drawing-in both by relieving the drawer-in of excessive visual strain, and also for expediting the work, there have been devised a mechanical appliance known as Barber tying machine.

" *Healds and Reeds must be cleaned & kept in order.*"

The drawing-in mistry or jobber is provided with an assistant for the purpose of cleaning healds and reeds as they come back from the weaving shed, and also to gait up setts ready for the drawer-in. Pumice stone and a little kerosine oil are used for cleaning Reeds.

This department should never be allowed to be in a dark room, there must always be sufficient light in this department. The new and old healds and reeds should not be mixed up nor thrown about carelessly, when they are not required. They should be arranged in racks according to their counts inches after brushing and cleaning them. The healds and reeds are very expensive items to be neglected from strict supervision. The beams are distributed to the looms either by a clerk particularly appointed for the purpose or by the drawing mistry. Each weaving-line jobber puts down his number

and the number of the loom that is coming out empty an hour or two in advance on a board in the column provided for the width of loom. The beam should be placed behind the loom half an hour or so before it comes out empty. Some mills have overhead runways for the beams others provide coolies for carrying the beams to the looms on their shoulders.

Defective Sizing and Varnishing of Heald.

A defective sizing and varnishing of healds will produce detrimental effect in the looms, such as, swollen and twisted twine, eyes closed or sideways to the warp instead of open and facing it, roughness, lumps of size and varnish in the eyes, rigidity, stickiness, and lack of lasting properties. Healds should be flexible, smooth and capable of resisting friction and strain, the twine of which the healds are made should vary in thickness and strength to suit the warp it has to actuate.

Care of Reeds.

A rusty reed is useless. A rusty reed should be steeped in kerosine oil for a few hours to loosen the rust which may then be removed by brushing with a fine wire brush. If the rust has pitted the wire the reed is useless. Reeds should not be brushed sideways as this tends to scratch the edges of the wires. Reeds should be stored in a dry place and should be kept flat. Reeds should be examined to note any shuttle-tip marks or flattened wires due to temples being set too close to the reed. These faults should be remedied in the shed. Every care should be taken with reeds, when not in use. They should be placed in racks and kept dry. Moisture readily attacks the reed wires and the rust is difficult to remove.

To Repair a Damaged Reed at the Loom.

Remove the slay cap, and release the tension of the warp so that the reed can be drawn to a convenient position. Place a piece of wood between the cloth and the reed and examine the baulks to ascertain from which the dents have drawn out of position.

If the reed is badly damaged, do not attempt to force the dents back without first heating the pitch by means of a lighted match or taper. By gently working a sharpened stick or a reed knife along the damaged dents, they can be moved back to their original position. The dents should be handled very carefully and no undue pressure

to twist or bend them back. In most instances, the dents are only sprung from their position on the band, and if only a slight sprain exists, a gentle tap on the baulk forces them back.

Weavers very often increase the difficulty by trying to repair a reed wire with the scissors or reed hook. It is not possible to successfully repair a reed in the loom without first removing the slay cap and moving the reed wires back to the baulk from which they have been drawn out of position.

Production.

Ends per hour, depending chiefly upon the human faculty, and such attributes as personal ability, dexterity as a special aptitude for the work, qualifications that are in no way assisted either by mechanical agency or any other external influence.

Particulars of Beam Stand.

Description.	Size	No	Production per boy per day of 10 hours.	REMARKS.
Drawers Stand	80"	22	15,000 end.	Depending on the ability of the Drawers and the class of work.

Hands Employed.

Designation.	No.	Amount			Rate per 1000 Ends.								
		Rs.	As	Per.	Plain.		Fancy.						
					As	Ps	As.	Ps	As	Ps	As	Ps	
Drawing Mistry.	1	40	0	Month									
Assist. ,,	1	30	0	,,									
Drawers	22	Piece work			1	0							
Reachers	22	,,	,,		0	9							
Beam cooly	4	18	0	Month.									

Stores Consumed.

Description	Quantity. No.	Quantity. Lbs.	Per a	
Healds..	....	....	Month	According to nature and class of work, and the efficiency of supervision.
Reeds	....	....	,,	
Pumice stone..	....	6	,,	
Healds staves	....	6	,,	
Do. Elastic	....	....	,,	
Do. Wire	....	....	,,	
Cocoanut oil	....	1	,,	

Size of Room.

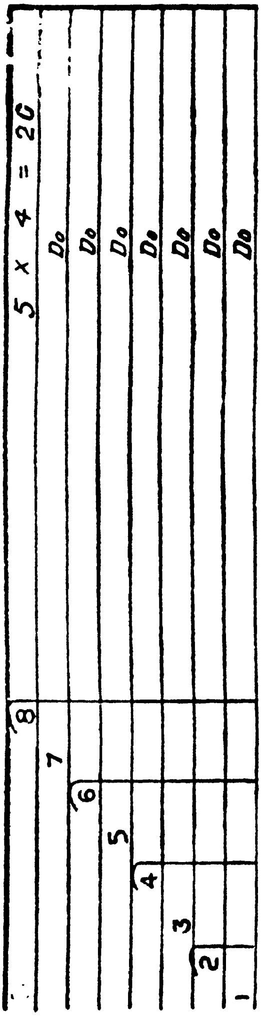
Room L.	Room B.	Room H.	Door. No.	Door. Size	Windows No.	Windows Size.	Sky Lights. No.	Sky Lights. Size.	
60.	18.	12.	2	5' 6" × 4' 6"	2	6' 0" × 4'-6"	2	11' × 11'	
..	..	..	..		..		..	....	
..	..	..	..		..		..	....	

Heald Knitting Plan.

Construction of Heald Knitting Plans for Stripe Drafts.

In weaving stripe drafts in knitted healds it is necessary—particularly if the stripes are broad—for the healds to be knitted to coincide with the pattern in order to ensure smooth working. There should be the required number of eyes on each shaft, and each eye should be in the correct place on the shaft in relation to the position in the reed of the end which passes through it. The order of knitting the healds is decided by three factors: (1) the draft; (2) the order of denting; (3) the number of Splits of the reed per unit space.

"Straight Draft."



To find counts of healds:—

(1) Ascertain (*a*) counts of reed; (*b*) the number of ends to the inch; (*c*) the number of dents to the inch.

Now proceed thus:—

Reed = 40, Ends = 40, Dents = 20.

(2) Divide the total number of dents to the inch by the total number of dents in the pattern. This will give the number of healds in each shaft.

$20 \div 4 = 5$ healds in each shaft.

(3) Then multiply the number of healds in each shaft by 4, and this will give you the counts of healds.

$\therefore 5 \times 4 = 20$ which is count of each shaft.

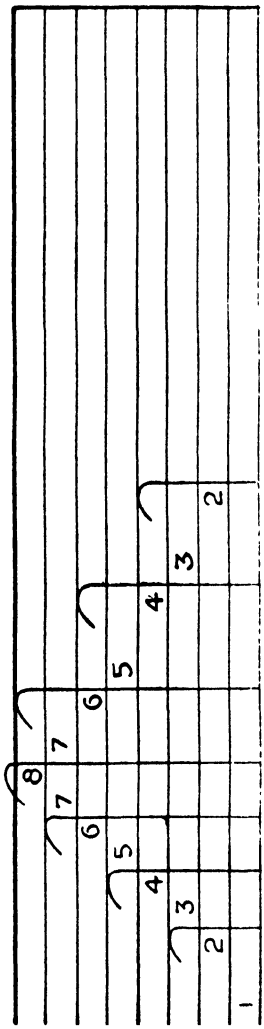
Q. A warp containing 2400 ends, plus 40 for selvedges, is drafted in a set of 8 healds with a straight —over draft and is knitted for a 64 Reed, Stockport counts, 2 ends in each dent. Find (1) at what rate per inch are the eyes knitted ? (2) what is the number of eyes on each heald ? (3) What is the width of the healds ?

A. (1) The rate of Knitting on each heald $=64 \div 8=8$ eyes per inch.

(2) The number of eyes on each heald, plus 4 for the selvedges (2 extra on each side) $=\frac{2400}{8}+4=304$.

(3) The width of the healds $=304$ eyes at 8 per inch $=304 \div 8=$ 38 inches.

V. Draft.



To find the counts of healds :—

(1) Ascertain (*a*) counts of reed ; (*b*) the number of ends to the inch ; (*e*) the number of dents to the inch.

Now proceed thus :—

Reed $=40$, Ends $=40$, Dents $=20$.

(2) Divide the total number of dents to the inch by the total number of dents in the pattern. This will give you the number of healds in each shaft.

$\therefore$ $20 \div 7=2$ 855 healds in each shaft.

(3) Then Multiply the number of healds in each shaft by the number of ends in each shaft and then multiply by 4.

Thus :—

$2.855 \times 1=$	$2.855 \times 4=$	11.42
$2.855 \times 2=$	$5.700 \times 4=$	22.84
Do.	do.	= Do.
Do.	do.	= Do.
Do.	do.	= Do.
Do.	do.	= Do.
Do.	do.	= Do.
$2.855 \times 1=$	$2.855 \times 4=$	11.24

————

$159.88 \div 4$

$=40$ practically.

Q. Suppose a knitting plan as shown above is for a design.

(1) to be woven with a 64 Reed, Stockport counts, the cloth to contain 2560 ends, exclusive of selvedges, with a V draft on 5 shafts having 8 warp ends and 8 picks of weft per repeat.

(2) give the rate of knitting for each heald and the number of eyes on each heald, over a reed of 2560÷64 =40 inches wide.

A. *Rule* ;—Multiply the number of ends per inch in the reed by the number of heald eyes in one repeat of the draft, for each heald, and divide the product by the total ends in one repeat of the draft.

Rate of Knitting =

$$\frac{\text{Ends per inch in Reed} \times \text{Ends in one repeat of draft, for each separate shaft.}}{\text{Total ends in one repeat of draft.}}$$

The draft is straight for the ends 1 to 5 and then reversed on the fifth shaft to the second one for the last 3 ends Nos. 6 to 8, as ends Nos. 2, 3, and 4 are raised and depressed in unison with ends Nos. 6, 7, and 8. Applying the rule, the rate of knitting and the number of eyes on the heald shafts are as follows :—

Shafts No. 1 and 5.

$$\frac{64 \times 1}{8} = 8 \text{ eyes per inch; 2 shafts, 40–in.}$$

Reed =8 ×2 ×40 =640 eyes.

Shafts No. 2, 3, and 4.

$$\frac{64 \times 2}{8} = 16 \text{ eyes per inch; 3 shafts, 40 in.}$$

Reed =16 ×3 ×40 =1920 eyes.

640 ×1920 eyes =2560 eyes Total.

Bitting.—Drawing-in additional ends at the side of healds and reeds in case of a wider warp having to be used.

Cumber Board.—A perforated frame of one length of wood or a number of wood slips for the guidance of the harness in the jacquard or some dobby shedding motion (particulariy *Dhoty* borders.)

Dent.—A space between the wires of a reed, otherwise split.

Doffing or Loomer's comb.—See striking reed or comb.

Draft.—A plan showing the order in which the ends are drawn through the healds. The ends are imparted to the drawer-in by the reacher.

Drawing-in.—A term employed to indicate the drawing-in of the warp threads, from a weaver's beam, through the eyes of the healds and dents of a reed in the order indicated by the draft and denting plan supplied by the fancy jobber or the weaving master.

Double Reed.—It consists of two sets of wires with the dents of one set opposite the spaces of the other. Suitable for warps with a large number of ends per inch, prevents choking of the reed and 'beading' due to fibres forming into small lumps or beads.

Dresser Reeds.—Made with strong wires and baulks open spaced. Used for dividing the threads in warp dressing.

Entering Draft.—The system of drawing the warp through the healds.

Expanding Reeds.—The dents are arranged between the coils of a spiral spring arranged on a screw. By drawing out or contacting the spring the dents may be adjusted to any desired width. Used for adjusting the width of yarn in various winding and beaming machines.

False Reeds.—A false reed is placed on the loom in addition to the ordinary sley with the idea of opening out the loose fibres of a fibrous warp. It is composed of small wires about 7 inches long, with a loop at the top; these wires being threaded on band or wire, the latter being preferred. These wires are passed through the warp behind the ordinary sley, and divide the warp into groups of three or four reeds as desired. The band or wire supporting the false reed is suspended from looped wires behind the top shell or hand rail, and looped wires are also placed behind the sley rack. For the later a heald shaft is placed in to keep all the wires composing the false reeds in position. The wires of the false reed have a certain amount of horizontal freedom which is limited by the tension on the warp.

Observation has to be made to see that no false reed wires are rigidly held by nuts or bolt ends behind the sley rack, as this may make a reed mark in the fabric.

Flexible Reeds.—In this type the wires or dents are kept in place at one baulk by pitch band and at the other baulk by fine wire. This allows the dents to "give" and easily pass knots and lumps. They

are used for weaving fancy warp-yarns such as 'spiral,' 'slub,' 'knop,' and other varieties. These yarns having irregular surfaces, an ordinary reed would tend to destroy the special effect and also cause breakages. These reeds are also employed to advantages for ordinary warp yarns with a large number of knots and slubs.

Fly-reed.—For loose reed.

Gauze Reed.—A reed twice the ordinary depth and arranged with eyed half dents midway between ordinary dents. Used in Madras muslin gauze weaving, the crossing ends being drawn through the eyes of half dents.

Gimp Reeds.—These are coarse pitch reeds with fine wires allowing more space for the warp threads. Used for gimp, spiral and fancy yarns.

Healds.—An arrangement for effecting the separation of the warp threads, so that the shuttle carrying the weft can be passed between them. The heald consists of a series of cords having an eye in the centre, and attached at each extremity to a flat piece of wood, called 'heald shaft' or 'stave,' the warp thread being passed through the eye of the heald,. Whenever the heald shaft is raised or depressed, the warp threads are also raised and depressed, and so the warp is separated into two portions for the shuttle to pass between, or, in other words, they are the most important feature in a loom, and, consequently, the resultant style of interlacing,, according to drawing-in and denting plan supplied by the designer.

Heddle.—Another word for heald. Also gears, combs, leaves of the caulm (harness in America).

Leasing Reed.—Consists of a deep reed with alternate dents soldered. Can be moved vertically to obtain a lease. Used in section warping.

Ordinary Reeds.—Consisting of rustless wire or brass, the wires being kept in place by pitch band at each baulk. Suitable for all ordinary classes of cotton goods.

Shaft.—Heald.

Striking Reed or Comb.—A half reed or comb, the wires being pointed. Used to evenly divide the warp to allow the threads to be picked out straight in drawing-in or twisting. May be used on any warp where a definite lease is not made at the beaming process.

V-Reed.—A reed arranged in the form of a V hinged at the point. Used on a section warper to adjust width of yarn.

Warp Ondule Reed.—These reeds may have the wires converging towards the top to give shaped fabrics as slipper uppers, or the wires may converge in groups alternately towards top adnd bottom to give wavy lines during weaving. The reed is raised and lowered during weaving at some definite rates.

Weft Ondule Reeds.—The dents are parallel but set in advance of each other front and back to give a wavy beat up to the weft.

Zig-Zag Reed.—Used on a slasher sizing machine and dry tape to adjust the width of yarn.

CHAPTER XXXIV.

WEAVING.

Weaving is one of the oldest of the textile arts and the last process of manufacturing cloth and the one in which all the preceding ones culminate.

Looking at the standard loom as produced to-day, and comparing it with the loom of, say, 30 years ago, one is bound to admit that there has been very little change. Many of the most important advances in loom design made in recent years have been in connection with Automatic weaving, and chiefly in weft supply mechanism. Automatic looms are also being developed to deal with most fabrics, including silk and artificial silk.

Weaving consists in interlacing two sets of threads, one set placed longitudinally and the other transversely in a fabric in such a manner as to produce a firm texture, fitted for the varying uses to which cotton cloth is adapted—for wear, for ornaments, for trade purposes, and for sale.

As weaving is the art of interlacing spun threads to form a fabric, it came after spinning, but as to the length of the interval between the invention of the spun thread and the advent of the weaver there is no means of knowing. Weaving is an art, and the motions of the art spirit are not along the plodding levels of material things, but by leaps and bounds. Climatic conditions, resources in raw materials, and social changes affect the progress of every kind of industry, but the world process still remains, and if one nation has chanced to overlap a stage or two in the movement from the lowest to the higher fabrics the whole industry has moved forward in the slow plodding manner from grade to grade.

Warp Yarn.—The longitudinal or warp threads having been carefully arranged and evenly wound in a sheet form upon a beam must be separated into two lines, and a transverse or weft thread which is placed in a shuttle passed through the division, and thus interlace with the warp when the warp ends are raised or depressed.

Weft Yarn.—The weft yarn, whether in mule cop or ring bobbin, leaves the mule or the ring frame in the condition in which it is required at the loom.

Indications by means of which twist can be Recognise d from Weft.

(1) If a piece of cloth contains a part of the selvedge then the warp will be those that run in the direction of the selvedges. (2) The warp is generally harder twisted as it is given more turns of twist per inch than the weft to make it stronger in order to overcome the strain that it has to undergo in the process of weaving. (3) The warp is generally coarser than the weft, in a piece of cloth. (4) If a piece of cloth is raised the direction of the nap indicates the warp yarn. (5) Threads of different counts may be used for the warp, but generally of one count is used for the weft. (6) Reed marks will always indicate the warp, since they run warp way of the goods. (7) Any fabric of a striped character will usually indicate the warp at once, as the stripe in most cases runs in the direction of the warp. In the case of a checked cloth, the prominent lines indicate the direction of the warp. (8) Two-fold yarn is generally used for warp and single yarn for weft. (9) Warp yarn is generally sized. (10) Where the members of one set of threads are equidistant and the others at irregular intervals, the former are usually the warps. (11) In stiffened or starched goods, if only the threads running in one direction can be seen, they may be assumed to be the warp, and if one set appears stiffer and straighter, the other being rough, crooked or crumpled, the former may be regarded as composing the warp and the latter the weft. (12) The material also affords a clue, since if one set of the threads is of better and longer material and higher yarn number than the other set, the finer constitutes the warp, and the commoner, thicker yarn, the weft.

How patterns are formed.—It is by the proper selection of warp threads for successive upper and lower line that patterns are formed in fabrics. Instead of threads, filaments or stripes may be used, and the fabric may be of all kinds, from the finest muslin to the heaviest bagging. Closeness of texture is an essential quality in all cloths, this being necessary to coherence of the fabric, but firmness to texture, and hence demands the sacrifice of lightness. In tropical countries the climatic conditions are such that fabrics of a more flimsy character are in demand.

Plain Loom.

The machine required for the weaving of plain cloth or cloth in which each end of weft and twist is interwoven alternately and on the face of which no figure is shown, is a simple and plain loom.

Looms may be divided into three classes—namely, (*a*) tappet; (*b*) dobby; and (*c*) jacquard looms.

The looms must be numbered with paint. The jobbers number should also be painted on a side.

Automatic Looms.

Automatic weaving refers, to the production of woven fabrics by looms in which the weft is automatically renewed in the event of breakage or exhaustion, without stopping the loom or requiring the attention of the weaver. Looms in which this principal object of automatic weaving is attained are included in the general class designated as Automatic Looms.

Types of Automatic Looms.

Automatic looms are of two principal types, namely, weft-changing looms and shuttle—changing looms. A weft-changing loom is one in which, when the weft becomes broken or exhausted, the bobbin, or the cop, is ejected from the shuttle and another with a fresh supply of weft is inserted.

A Shuttle-changing loom is one in which the Shuttle itself is ejected and another inserted when a weft failure occurs. In both machines, the operation of supplying fresh weft is entirely automatic There is, of course, a vast difference in the construction and operation of looms of each of the two classes.

Economy of Automatic Looms.

In some mills only sixteen or twenty automatic looms are assigned to one weaver; in other mills each weaver operates twenty-four or twenty-eight and, in some cases, even thirty-two looms.

Spead of Various Sizes Wortb rop down.

Width of Loom.	Rev. per min.
28	190
30	185
32	180
34	175
36	174
38	170
40	165
42	160
44	156
46	152

Width of Loom.	Rev. per mix.
48	148
52	144
56	140
60	136
65	132
70	124
80	118
90	104

Speed of Looms.

The make and style of loom most suitable for any particular mill will of course be determined by the class of work the mill is engaged on, but in making a selection it is well to remember that speed is not necessarily the most important consderation. For an example in the experience of the author where he had in a mill but in two separate sheds 36-inch modern looms running at the rate of 220 picks per minute and the same width of old looms running at 206 picks per minute. These slower-running looms turned off more and better cloth, per loom, than the modern looms at a higher speed, and at a much lower cost for upkeep. As the result of the lower cost the author decided to lower the speed of the modern or latest looms to the old looms and the result was found to be very satisfactory.

Tuning of Looms.

The loom is a machine in which a series of intermittent movements are required to control its various parts and all must be accurately tuned and fixed to ensure a regular sequence. The aim should, therefore, be, to so unite the parts that one cannot get out of harmony with another. Uniformity and steadiness in working are essential in all machines, but this applies perhaps in a special degree to power looms, consequently, if the rate of speed at which the loom is being run interferes with or affects this in any degree, the result must be proportionately detrimental. With respect to the working parts of the loom and the material being woven, an increased speed means an increased strain, and hence it must be kept within limits which will not be injurious either to the loom or to the fabric. In connection with this question of speed, we have to consider not only the calculation of speed of machinery in various parts but also power required for the work to be performed, and strength of materials, etc.

How looms are set out.—Looms are generally set out in groups of four; that are two right-hand two left-hand ones, running diagonally, so that they will do when so set out for either two or four loom weaver.

Right-hand and left-hand looms.—To economize driving power, line shafting and space, looms are made right and left hand; a right-hand loom is one where the driving belt is on the right-hand side of the weaver when tending the loom, whilst a left-hand loom has the driving belt on the left-hand side of the weaver.

The work of arranging the correct position for the looms and of squaring, levelling and nailing them down, is of most vital importance

The four-arrangement, is adopted for convenience to the weaver, as the looms having the starting ends continuous, he has little walking, for the purpose of starting or setting on the machine. Thus two 'Hands' of loom are required, those with the starting handle at the right-hand side being named right-hand looms and *vice versa.*

Width of a Loom.

The term width of loom may mean either (*a*) the greatest width of cloth that can be woven in a given loom, or (*b*) the reed space of the loom, that is, the distance measured from the weft-fork grid on one side to the box back on the other side.

The Position and Height of line Shaft.

The looms are driven from the shafting running parallel to the looms when looked lengthway. The line shaft which is $2\frac{1}{2}''$ dia. and making about 150 R.P.M. should be fixed transversely to the light in order that the loom slays shall not throw shadows on the warp.

The height of the line shaft which transmits motion is of some importance in connection with obtaining a good steady drive to the loom. A distance of 12 or 13 feet from the floor is most general and economical. In all cases, however, the distance between the two pulleys should be such that only a slight sag is permitted on the belt. A heavy sag, resulting from an excessive distance between the shaft pulleys, will result in a poor drive; much power will be lost in the uneven swinging of the belt, and in the increased friction brought to bear upon the shaft bearings.

The loom should be fixed lineally one with another. The line shaft runs over the space between the warp beams of the looms. The connected shafts should never, if it can be avoided, be placed one directly over the other, as, in such a case the belt must be kept very light to do the work.

It is also desirable to locate the shafting and machinery so that belts shall run off from each other in opposite directions. This arrangement will relieve the bearings from the friction that would result, were the belts all to pull one way on the shaft.

Above each pair of looms, the line shaft carries a drum wide enough to accomodate the two driving belts. It is advisable to have the line shafting as high as practicable above the looms, in order to obtain the advantages of comparatively long driving belts together with reduced wear of the half-crossed belting. A half-crossed belt is less easily shifted from the fast to the loose pulley or Vice-Versa than is an ordinary open or crossed belt; also, with a half-crossed belt there is considerable friction between the belt and the strap fork through which it passes, producing wear and tear of the selvedge of the belt and of the spikes of the fork that may result in breakage.

Loom Pulleys.

Drums which are generally 14 or 16 inches in diameter on the line shafts drive the loom pulleys which are of various diameters according to the width of looms, but they should at least be 8½ to 9 inches in diameter, by means of straps (leather, camel hair, or rubber belting).

Electric Drive.

Looms of recent date are often driven by electricity. With an individual drive, each loom has its own electric motor, power being transmitted from the motor shaft to the loom crank-shaft in various ways, as by a belt and pulleys, or through a train of gearing, a friction clutch being sometimes inserted between the motor and the loom. The gear drive is considered the best for heavy goods, as there is entire absence of belt slip, which often gives trouble in picking. A clutch is usually employed, in order to prevent damage to the electric drive motor when the loom knocks off.

Electric Group Drive.

If a group drive is adopted, the looms in the shed are divided up into sections or groups, each of which has its own length of line shafting; this overhead shaft is driven by an electric motor, power being transmitted to each separate loom by pulleys and belting.

With a group electric drive, the drive to separate looms would be by belt in the ordinary way, but the overhead shafting would be much shorter and lighter than if power were transmitted directly from the engine to those shafts through belts, ropes, or gearing. Further it would be possible to run any group or number of groups independently of the remainder, thus avoiding the waste of power through driving a lot of idle shafting and belting.

Individual Electric Drive.

In the case of individual drive there will be the entire absence of line shafting overhead, leading to greater cleanliness and better lighting of the shed; saving in cost of power, because the current is shut off at the motor shenever the loom is stopped; steadiness of the drive, leading to uniformity in the quality of goods produced, a quick start up, the loom needing no assistance from the weaaver when setting on. But the disadvantages are as follows :—risk of damage to the motor or the transmission gearing through the shock occuring when the loom bangs off, or stops suddenly by reason of the stop—motion functioning when the shuttle fails to enter the box; liability of the loom to turn over a number of picks, that is, for the crank—shaft to make several revolutions, which chiefly happens with old looms, whenever the loom is stopped by the weaver or whenever the weft breaks and the appropriate stop-motion functions. This last disadvantage is produced by the high speed of the electric motor, whose shaft may make anything from 850 to 1100 revolutions per minute, and the energy is consequently stored in the revolving armature and belt pulleys, which energy must be dissipated, and the whole brought to a standstill in order to stop the loom, since there is loose pulley on the loom shaft as there would be with a line-shaft drive. On the other hand, this disadvantage would altogether disappear if a friction clutch were interposed between the motor and the loom shafts, more particularly if the disengagement of the clutch were accompanied by an efficient braking action on the loom. A good over looker will ensure that the brake acts properly to stop the loom without excessive overrunning.

"Speed of Looms"

Width of Loom	Speed of line Shaft =143 R.C.M. Drum =14" — Pilleys P.	D.B.	Calculated Speed. P.	D.B.	Speed of line Shaft =158R.PM Drum =14" — Pulleys P.	D.B.	Calculated Speed P.	D.B.
26	9	—	222	—	9	13	240	168
28	9¼	—	216	—	9¾	13	228	168
32	9½	12¾	210	157	10½	—	216	163
36	9¾	13¼	205	154	10½	—	216	163
40	10	13½	202	148	11	—	202	—
44	10	—	202	—	11	—	200	—
46	10½	13¾	190	145	11¼	—	193	—
48	10¾	—	186	—	—	—	190	—
50	11	—	182	—	—	—	188	—
52	11¼	—	178	—	—	—	188	154
54	11½	14½	173	138	12½	—	178	—
56	11¾	—	170	—	—	—	178	150
58	12¼	—	163	—	13	—	168	—
60	12½	14¾	160	135	13	15	168	146
64	12¾	—	157	—	14	—	159	—
66	13	—	154	—	14	—	159	—
72	13½	—	148	—	—	—	152	—
74	13¾	—	145	—	15½	—	145	—
80	14	15	102	95	—	—	102	—
100	16	—	90	—	—	—	90	—

Effectiveness of drive and loom speed may be materially assisted by having the fast pulley slightly larger than the loose pulley. This ensures that when the belt is moved from the loose pulley to the fast pulley it will be driving tight. Care should be taken to have the belt run clear of the guide. Not only does the rubbing act adversely on both the guide and the belt, but the belt may be torn if the clasp or the lacing comes into frequent frictional contact with the guide. The final precaution to be taken in the handling of a fast and loose pulley drive is that of having the loom crank in proper position for starting. Smaller loom pulley result in excessive vibration, especially on fast reed looms. Many breakages occur, generally when the loom is being started, because the belt will have insufficient surface grip on a small pulley. One pulley is loose on the shaft, the other keyed to it. The former

carries the strap when the looms is stopped. The belt is guided from one pulley to the other by means of a fork which is governed by the starting handle, and can be pushed in and out of contact with the fast pulley as desired.

Loom arrangement in a Weaving Shed.

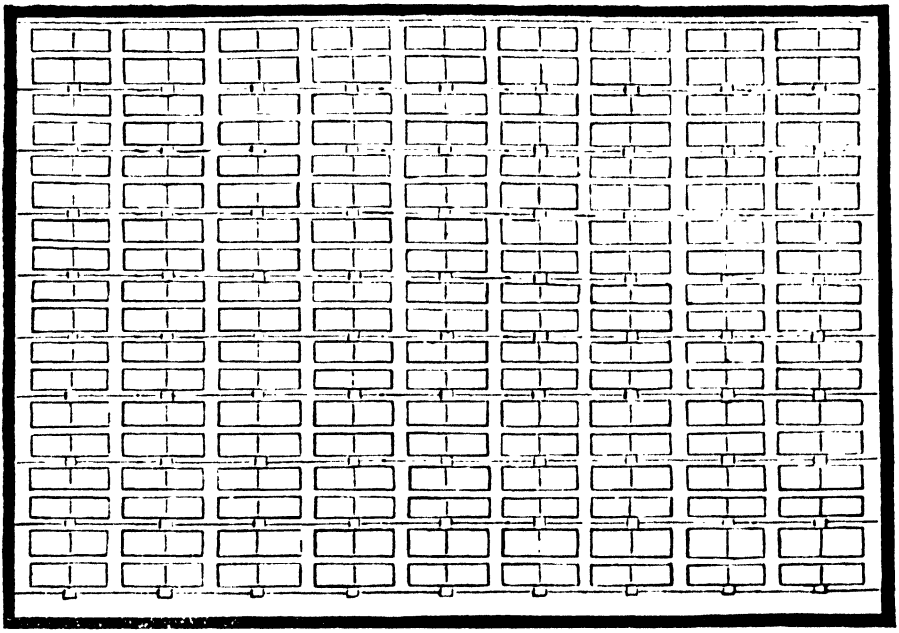


FIG. I.

Situation and Description of a Loom Shed.

A good passage round each group of four looms and broad alley say 4 to 6 between fly wheels here and there running the whole length of the shed is quite necessary for the conveyance of twist or weaver's beam to the looms. As to the distance looms should stand one from another depends upon the size of room or shed to make such a number of looms stand in a given space. One of the greatest mistakes made in shade arrangement is the smallness of alleys. Because jobbers and weavers can work better and turn out more cloth when their movements are not cramed and there are less chances of damages in broad alleys than in narrow alleys.

Unlike the spinning which is carried in a building five or six stories high, the manufacture of cotton goods take place in a shed

which is toplighted and saw-toothed though in some places the roof of the weaving shed is built flat with skylights..

The glass roofs in saw-toothed roof run from east to west to allow northern light to enter the shed. This the most uniform and prevents the direct rays of the sun from entering the building, as the sun's rays are seldom so powerful at rising as at setting.

The window panes are whitewashed if not painted from outside or inside. This helps to keep the shed from within cool during the hot season, though the light is effected to a certain extent.

The saw-toothed type of building not only ensures good light, also solidity of foundation, freedom from vibration, better ventilation, and more uniformity in the humidity and temperature of the atmosphere than buildings of several stories. It is also more convenient to arrange machinery and wheel gearing for driving. *Convenience, economy* (particularly that the material will not be taken over the same ground twice) and *healthy surroundings* should be in the *foremost consideration* of a weaving shed. In a shed the machinery can be placed more conveniently and it is of better supervision. The pillars in a loom shed are generally placed 22ft. apart breadthways. Therefore there will be 2 looms of 40 inches breadth- ways and 3 looms of 40 inches lengthways.

Space Occupied.

The space occupied by a 48-inch loom is 7 ft. 7½ inches by 3 ft. 8 inches. This is for a loom that has a slay 87½ inches overall, a reed space of 48 inches, and will weave 44-inch cloth. For wider looms it is necessary to add the extra reed space to the 7 ft. 7½ inches and vice versa. When looms are fitted with a direct—geared electric motor it is sometimes necessary to add 6 to 12 inches to the overall length of the loom. In present-day practice, alley ways are wider both behind and in front of the loom than formerly, in order to give more air space and better working conditions to the workers.

Points to Remember when Erecting Looms.

On opening the cases it will be found that those parts that are next to the driving end will be marked 1 the other 2 or 1 A, 2A and so on, the same with all other parts, always those next to driving end will be marked as No. 1.

The Laying of the Looms.

In laying out the looms in a weaving shed it is very essential that the widest looms should be placed nearest the driving end; or, if driven by electricity, that point nearest its connection with the motor. The lighter looms should follow farther out. This arrangement will reduce the torsional strain thrown on the line shafts. In order to have some regularity and economy in space the looms should be grouped in fours as shown in Fig. I. This arrangement further shows that all the four belts are grouped together, leaving sufficient passages around the looms for the movement of weavers and others.

How to put the Loom in its Proper Position.

Loom shafts are set parallel and perfectly square with the line shafts. In other words the crank shaft of the looms should run parallel with the driving shaft and the looms should be thoroughly bedded on the floor, with all its parts level. To obtain this a plumet is dropped from different points along the first line shaft, and where it touches the floor a permanent mark is made with a chisel. A chalked cord is stretched over two such marks, lifted at the centre, and suddenly liberated, when a straight white line is left on the floor, and it must be extended from wall to wall. Similar lines may be madce below alternate shafts, as the intermediate ones may be measured, after which two marks are made 10 ft. to 12ft. apart upon one of the line, each is used as a centre from which two intersecting arcs are described by means of a piece of long light wood through which a nail is driven near each end to make a line at right angles to those already traced, from these lines the position of the loom feet can be obtained, care being taken to fix them so that the pillars will not unnecessarily obstruct the back alleys that is, just leaving convenient space for getting between two full beams, beams, otherwise if the weaver finds difficulty in getting behind his looms, he will go behind as seldom as possible, and amongst other things, will fail to regulate the warp lever weights with the frequency and care which an even piece demands. To test the accuracy of these measurements, the breast beam of each loom as set must be examined in a line with the breast beam of the previously deposited one.

Then a long straight edge with a spirit level on the top of it is placed upon a loom in various positions, that is, on the tappet shaft and loom sides, to ascertain if a packing is required beneath the feet, if so, pieces of wood are cut to the required size. Then the position of the foot holes are marked, the loom is removed, holes are

drilled in the flags or floor, and dry wooden pegs are tightly driven into them. The loom is then put back into position, and long nails are driven through the feet into the wooden plugs, the latter swell with the moisture of the floor and hold the loom securely. The ends of the loom must be set parallel also, so that on looking down the shed a straight row of machinery will be observed.

To set the ends of the looms—one out and one in—so that it may be square to the passage in front and behind the loom proceed as follows ;—

Let A. B. Fig. II.—represent the line already drawn on the floor and C the point from which the line at right angle is to to be

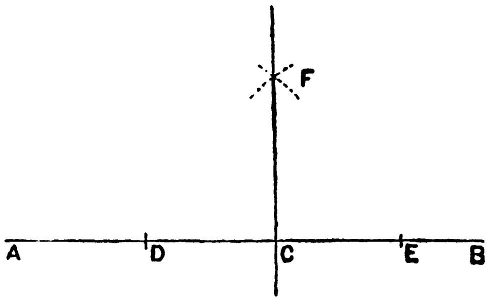


Fig. II.

drawn to it with a beam compasses, then on point C with any convenient radius mark off points D and E. Then with these points as centre with the same or any other convenient radius describe two arcs until they cut each other in point F. Through points C and F draw a line as already described, extending it as far as may be necessary. In case the line C.F. Fig II meets with an obstruction due to it being near a wall etc. then proceed thus :—

Let the line A.B. Fig III be the line alreday established, and

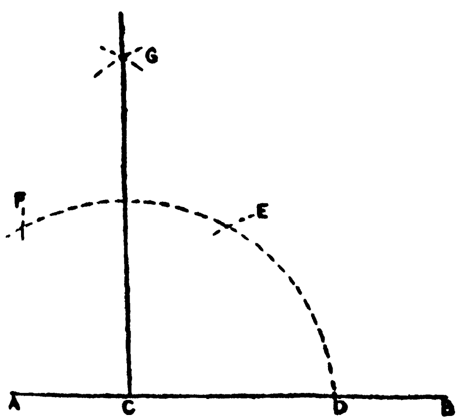


Fig III.

C the point from which a line at right angle is required to be drawn

or extended. Then take C as centre and with any convenient radius describe an arc cutting the line A B in point D. From point D as centre with the same radius mark off point E, and from point E as centre with the same radius mark off point F. The points E and F with the same or any other convenient radius describe arcs till they cut each other in point G. Through points C and G draw the line required. As the lines are drawn up, the holding down bolts to fix the looms to the floor may be proceeded with

How to prepare a Template to save Time.

In order to save time and hard work moving about looms on the floor, first putting them in position and marking off the holes, then moving them out of the way to get the holes made and then moving them back again, a template becomes necessary as Fig. IV. It can be made of pieces of wood nailed together with the holding down bolt holes in it, with a centre line representing the centre line of the crank shaft, and for accuracy, of course, the front of the loom is marked on it.

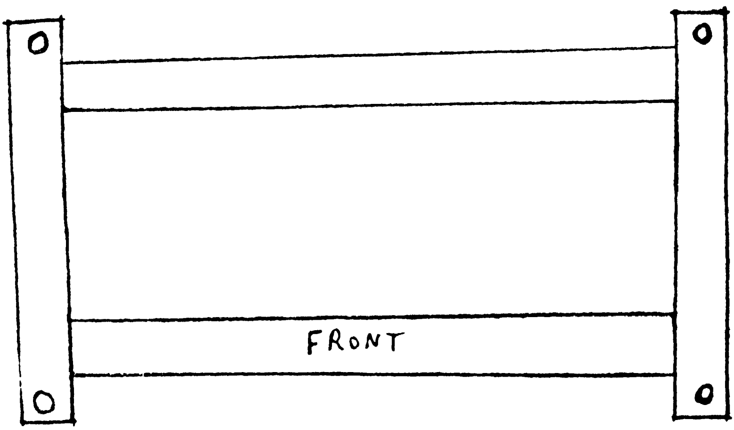


Fig. IV.

It is only necessary to lay down this template, with the centre line parallel to the line already drawn on the floor, and arrange it to the line drawn at right angles as required. Then the holes should be marked and the bolts put in.

Assimilation of Loom Parts.

In assimilating loom parts together care must be taken that the main wheels that is the crank and Tappet shaft wheels are put in gear correctly, as this may save a considerable amount of labour

afterwards. The proper method for this is to turn round the Tappet shaft until the picking point presses out the picking cone to its full extent, then turn back the crank until it forms an angle of 45° with a horizontal line drawn through its centre.

Fig. V. is a skeleton diagram showing the picking point full out on the picking bowl A with the crank shaft B standing at an angle of 45°, with a horizontal line drawn through its centre on its

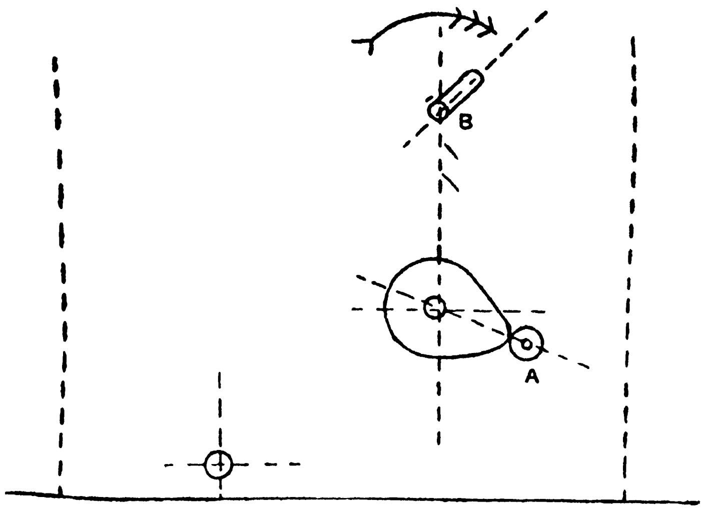


Fig. V.

movement backwards. Put the wheels in gear when the two shafts are in that position.

When to Start a Loom.

When a loom has been got to the place where it is intended to stand, then begin with heald-roller, strap, put them on. Then put on both the pickers, that is, plain pickers and the buffers, which are delivered to the mills readymade, but are much too solid to be placed on the spindles as a satisfactory cushion for the pickers without some further medium being applied to neutralise the solidity. An effective method is to obtain a piece of leather, 6 inches long by $1\frac{1}{2}$ inches broad, and at each end punch a hole large enough for the spindle to pass through. Thread both ends of the leather on the spindle so that the leather assumes a double condition and place it between the buffer and the spindle stud.

The advantages obtained by applying this method are that the life of the buffer is considerably lengthened, a much improved cushion for the picker is obtained owing to the leather effecting a more gradual stop to the picker when the shuttle has been delivered, and the picker does not wear out quickly.

Or another method is, leather washers $\frac{1}{8}$ of an inch thick and $1\frac{1}{4}$ inches in diameter may be inserted between the spindle stud and the buffer. Then the following are put on the picking bands, the check-straps, the springs to draw the picking sticks back, fit the shuttles to the boxes, examine the picking motions and see that they are set right and make them to pick with that force only as will send the shuttle easily from one side to the other, screw all the nuts and studs fast, and set the tappets. Then set the temples and taking up motion to take up one tooth at a time, then set the brake and weft fork, oil the loom well, put on the driving strap. In order to obtain the length of the belt or strap required, pass a line around the pulley on the line shaft and also around the pulley on the loom. Then cut the line to the exact length, and lay it on the floor and cut the belt to correspond with the line. Bear in mind that belts will stretch after being run a short time; consequently they should be cut short 1 to 2 inches. Lacing is generally used in the case of leather belts and fasteners in the case of camel hair or canvas belts.

Examine Loom before Gaiting Up.

Then let the loom run two or three hours before putting in the warp. Put in the warp and be particular in gaiting it up. Before gaiting a beam or placing it into the beam brackets, after a previous one has finished, the jobber must examine the loom while it is idle or waiting to see if there is anything loose or any repairs wanted that is he must inspect the settings and timing of the different parts of the loom. Also tighten up all bolts and nuts that are loose and replace any bolts or screws that are missing and see that the flanges of the beam are well secured.

All fluff on the loom must be removed by the weaver and all the oil holes properly cleaned out.

Every part where there is friction must be oiled or lubricated. The shuttle tips should be examined and repointed if necessary, and where ever a rough place is found on the shuttle, it must be made good by the use of a sand paper or a shuttle trimmer, and apply a little linseed oil, as these faults may cause the weaver excessive warp breakages. It is also a good practice to put a drop of oil on the

shuttle-tongue spring as this saves wear and tear. It may appear to be a loss of time in following the above methods (of cleaning the loom, etc.) but it is decidedly not, on the contrary, it is a great gain, because by attending to these three things—**repairing, cleaning, and oiling,** the loom will last longer, work better, and a few minutes spent in this way at the end of a beam may save hours of labour, time, etc., afterwards.

Gaiting of Warps.

Prior to taking the new warp to the loom, it is advisable to inspect carefully the beam flanges, ruffles and gudgeon pins, as well as the healds and reed. A damaged or loose flange or ruffle might not have been noticed in the beaming room and the same may be said of the beam gudgeons or pikes. Damaged reeds, broken heald cords and heald staves, are all met with fairly frequently and all the necessary repairing of these defects can best be carried out before the warp is taken into the weaving shed.

The beam is placed in the loom with the gudgeon pins or picks in their appropriate bearings, the beam being then rotated by hand to see that it runs in a "true" manner. It should then be examined to see that it is in a perfectly horizontal plane and parallel with the back rest or roller.

The warp yarn, together with the healds and the reed, is then passed over the back rest or vibrator to the centre of the loom, and the healds connected at the top to the straps which has hooks at one of its ends by means of cords attached to the healds roller boss.

In order to minimise the loss of time and obviate some amount of labour when gaiting up warps punch three holes at one end of the roller strap and one hole at the other. The end with one hole must have the set screw passed through and secured to the top heald roller. The other end of the roller strap enables it to attached to the healds. In utilising the three holes obtain a length of heald cord which, after being doubled, is passed from above with its loop through the second hole and threaded from beneath through the first hole. It is then laid between the two open ends projecting out from the second hole, and when the cords are tied together in a good secure knot, and, at the same time, a slip noose is formed. From the third hole in the roller strap fix a S. hook. The loop end of the cord extending from the top hole is passed under the heald staves and attached to the lower portion of the S. hook. The top cord is then always a fixture of the correct length, and one can save

time in warp gaiting, as after unhooking the cord from an old set of healds the cord is ready for passing under the new warp heald staves. Of course, the cord in the second hole with a slip noose is used for raising or lowering the top shed, but when the top cords have stretched thoroughly, the top shed will be the correct height and the bottom cord will seldom require adjusting, provided that the heald staves are not uneven in depth. When setting the heald roller shaft, care must be taken to keep the roller in such a position that they will have perfect freedom of movement in both directions without the straps riding on the heads of their fixing screws. The cords should be attached to the healds in such a manner that they will stand in their places when working—not pulling one against another. The portion of the healds' roller boss supporting the back healds is larger than for the front ones; this is to make the former when lifted make the same shed at the same angle as the front heald. The healds are connected at the bottom to the lamb rods that connect them with the treadles by means of hooks at half the lift both treadles should be in contact with the tappet, and in this position the healds are attached to them at uniform height although the latter generally done after the warp has been tied in. The reed is then fixed in the slay and held in position by the slay cap where a V-shaped groove has been cut to receive it and fits upon the top of the reed, so that it shall not move vertically, but shall be free to move longitudinally, for this will permit the reed dents to face the heald eyes. The reed must be maintained free from shakiness in its grooves, especially when the fundamental operation of beating up occurs. Any perceptible movement of the reed from back to front ought to be prevented in every instance.

A piece of cloth known as tab end, and which should be of the same as the cloth to be woven, is passed around the sand roller and carried over the breast beam. Bunches of the warp yarn are then taken and tied to the tab ends which should be torn in strips at this end. Care must be taken that all the ends of the warp are drawn at an equal tension before being tied to the tab end. Few picks with the correct change wheel and correct counts of weft are inserted by hand in the warp. The change wheel and counts of weft to be employed is obtained from the sizers' ticket that accompanies each beam. The actual number of picks contained in the cloth can be examined by a counting glass. Then gradually the loom is started and the cloth wound on the roller in front of the loom—which has a revolving motion in union with the rest of machinery—by turning the carrier wheel by hand till there is sufficient of grip on the cloth roller.

Adjustment of Shed.

The lower line of yarn should neither be made to press heavily on the shuttle race nor stand very high above it, because in the former case a great amount of wear and friction would occur, and in the latter there would be a liability for the shuttle to be thrown out; a medium position should therefore be maintained. The top line should not touch the reed top. If both the lines of warp are not as stated above then the healds are adjusted by means of cords and straps.

Temples, Weights, and Lease Rods.—Temples as a rule are set as near a reed as possible without touching, and with their front edge from $\frac{3}{16}$ to $\frac{5}{16}$ lower than the breast beam. When these things are done the loom may be set on to make cloth, and then it is said to be gaited on which depends the making of good cloth—the warp weaving well and ease to the healds given.

Warp Tension

In the process of weaving it is necessary to hold the warp somewhat tightly, each portion at the same tension, and to obtain this condition the cloth is pulled forward by the taking up roller as it is woven; but the warp is held back by the friction of weighted chains which passes round beam ruffles. The warp passes upwards from the beam, over the back rest, and thence to the back of the healds, between the back rest and healds are the lease rods—a large one with a smaller rod nearer the healds. By means of these rods the warp is separated into equal portions, two ends passing alternately over or under the thick rod, those passing over the thick one also run under the thin rod. The rule commonly observed for four healds is to have the ends passing the first and the third healds over the thin rod, and those drawn through the second and fourth over the thick rod, and consequently under the thin one.

The lease is formed by lifting the second and fourth healds and placing the back rod through the opening which is formed behind the healds and then lifting the first and third healds and inserting the front rod in a similar manner. The rods are then positioned about half-way between the healds and the backrest and secured by cords to the backrest or the side frames of the loom. Where an end-and-end lease is required the third and fourth healds are lifted by turning the crankshaft to the appropriate bottom centre position, and inserting the back rod. After turning the crankshaft a further revolution to lift the first and second healds, the front rod is inserted.

If the lease rods are placed too far apart from the healds the yarn has a tendency to get chafed, and thus weakened. On the other hand, when too near the healds too great a strain is thrown on the yarn, although a superior quality of cloth may be produced. Consequently the jobber must find a proper medium for their place in relation to the quality of the yarn and cloth to be made.

Drafting of Plain Cloth.

The first heald is the one nearest the front of the loom, the draft is 1, 3, 2, 4 this applies to plain cloth. Although the first and second healds are worked as one, and the third and fourth togethr. Regarding the two ends which pass together at the lease rods, the one through the front heald is to the left of the one through the third heald, whilst with the other couples, the end through the forward heald is to the left of the other. The weaver bearing these rules in mind, can thus find the place of any broken end.

The lease rods should be set for rough warps as near the back heald as the cloth is to the front heald; while cloths which require to have cover should be placed a long way back, because bringing them near the healds tighten the top shed.

Before leaving the loom, the jobber should examine the cover obtained in the cloth, and instruct the weaver as to the correct count of weft to be employed and to use only those warp threads (trumps) that are similar to on the beam and which can be obtained from the sizing department for piecing ends up when they break in the loom during running.

When Cloth Looks Well.

The cloth is woven pick by pick, and the whole action of the loom may be comprised in repetitions of the operations contingent on putting in one pick. In the making of cloth there are three important points to be considered to make a piece of cloth look well ; first, even; second, good cover; and third, good edges.

Weft yarn should be strong enough to weave without breaking. It should be as soft and full as possible, as this helps to make a good covered cloth, with a nice "clothy" feel when woven. If too hard twisted the weft is liable to be snarly, curly places appear, and the cloth is poor looking. thin, and looks of less value than it ought to do.

Generally speaking, the cloth made from soft twisted yarns will demand a better price than the harder twisted cloth. If for printing, then it must be a soft, full cloth to get a nice finish. If for dyeing, such a cloth gives a nicer tone and more even distribution of colour, while after bleaching, the cloth is not so harsh, and feels better that is, without a hard or papery feel.

Suppose the warp to be in position and the whole machine in weaving order, the first of the three primary movements (that is shedding, picking, and beating up) is to open the warp into two parts, and is called shedding. Though it is true that sundry others must also be performed, but they are all subservient to, and must work in harmony with these three.

Shedding.

Shedding is the most vital and the object of which is to make an opening for the shuttle to pass through and to change the position of the warp threads (that are drawn through the heald eyes which are lifted or depressed) after each pick, so that the warp and weft yarns will be interlaced together according to a definite plan or pattern. It is very important in figured cloth than in plain, for it is by the shedding in its varied character (that is the repeated change of positions of healds in an upward or downward direction) that fancy cloth is principally produced.

It is also most important as to the particular manner in which shedding must be accomplished, for upon the successful or un-unsuccessful shedding depends in great measure the quality of the cloth produced, as well as the quantity which may be made by one loom. How the quantity and the quality may be materilly effected are explained under the heading of "Faulty Cloth."

There are two kinds of sheds namely open and closed. In the latter the mechanism employed will bring the healds up or down to the central position of the shed each time a pick is inserted in the shed no matter how many picks the heald is required to remain up or down to form the necessary weave.

Bottom closed shed is especially suitable for weaving gauze cloths as the warp threads come to one level after every pick. In the former the heald shaft may be kept up or left down, and form a stationary line for two or more picks, as required.

Further, when a change or movement of heald is desired to form pattern it is caused to move directly from its highest to lowest or lowest to highest position for the formation of the new shed.

Open shed shedding motion is applied to tappet looms. Because the results obtained from this principle of working are less strain upon the warp threads and less power required to drive the loom.

The shedding tappets are set in such a position that the treadles are level when the cranks are at their top centre position. The larger tappet operates the back healds although it is optional which of the healds is depressed when the shuttle is picked from the starting side of the loom. The tappets on all the looms should, however, be so set that either the back or the front healds are depressed on this pick, otherwise trouble will be experienced through the back healds being inadvertently connected to the smaller tappet and the front heald to the larger tappet.

Tappets.

Tappets are both positive and non-positive in their action on the healds. A positive tappet is one which will either leave or depress the healds as required.

A non-positive or negative tappet is one which requires the help of springs or weights to bring the heald back to its original position after it has been operated on by the tappet.

For plain cloth, a two leaved negative tappet is fixed on the tappet shaft, under the loom for the sake of economy (or as the case may be) beneath the centre of healds. Two treadles move on a fulcrum pin each carries an antifriction bowl upon which the two leaves or plates act as they rotate. The healds being attached to the treadles by means of lamb rods and a hook which are secured to the bottom heald shaft or stave by means of cord. Cords and straps connected to the upper heald stave or shaft are secured respectively to the peripheries of two rollers. The shaft works freely in bearings when these tappets are in motion. The treadles are alternately depressed, and the under connections imparts a similar downward movement to the healds. As the tappets are incapable of lifting either the treadles or the healds, the upward movements is entirely obtained by top connections. Thus, as one heald shaft is depressed by a treadle, one strap is unwound from the roller and the other wound. Therefore a sinking heald is made to lift its fellow. Healds are placed at right angles to the warp threads and must be so

connected to the shedding motion that a vertical pull will be exerted upon them, for a side movement, however slight, is detrimental to good weaving.

The movement of the healds should be smooth and steady, commencing to move slowly, increasing in speed towards the centre of the stroke and becoming gradually slower after passing the centre, until they finally merge into full pause or rest. The shed must be left open sufficiently long to enable the shuttle being picked through. The movement should be regular and uniform, that is, maintaining the same rate of speed throughout. If the strain upon the warp is too sudden, considerable breakage must take place, particularly if the warp is of a soft or tender material. The opening and closing of the shed must also be tuned in the proper manner to the beating of the weft to the piece.

When weaving twills all the healds must lift to produce the same angle of shed each pick, and the heald furthest apart from the reed bears the greatest strain. For the same reason, if the structure of the design renders possible, the set of threads least capable or resisting the tension should be drawn into the healds nearesr the reed. Tappets for twills are fixed on a separate shaft placed parallel to the bottom shaft from which it is driven by spur wheel gearing. It is customary for the driving wheel on the bottom shaft to contain a number of teeth, which is a multiple for a good many weaves to be produced. The number of teeth required on the tappet shaft for different weaves is obtained by multiplying the number of teeth on the bottom shaft wheel by the number of picks in one round of the tappet to be used, and dividing by two, or which is the same as in a ratio of 2 : number of picks in one round of tappet.

In tappet shedding careful attention is required on the part of the overlooker or jobber as a good tappet and rightly set is of great importance, both to give a good cover to the cloth and make the yarn weave well, with as little strain on the healds as possible.

The movements of the healds must be entirely free from any jerkness in any part of their movement. To accomplish this the two leaves of the tappet must be so constructed that they remain in constant contact with the antifriction treadle bowls during their entire revolution without overstraining the cording or the healds.

The surface of the tappet is so shaped that the shed remains open for one third of a pick, known as a dwell. A greater amount of dwell causes increased tension of the yarn although the friction

is decreased. One side of the tappet is from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch larger than the other. The larger is to tread the back shaft, being the furthest distance from the reed, and the least side the front shaft. The strap from the larger heald roller passes round the back heald, and the strap from the smaller roller round the front heald (as already described in previous chapters). The back heald is lifted higher by this means, being operated by the larger tappet, and still enabling the same size of shed to be made by both healds at a point in front of the shuttle. The sinking of one heald causes the heald roller to turn round and lift up the other heald. It is very important that one should consider the relative size of the shed and the shuttle by heaving the lamb rods fixed to the treadles as near approaching the fulcrum in order to reduce warp breakages. Another point, worthy of consideration, is that the top heald roller shaft should be kept as far forwards as is conisistent with free movement of the front heald shaft behind the sley and the sley cap in order to keep the depth of the shed (and therefore the stress upon the warp) at a minimum. It is also important that the character, and extent of the roller's movement should be minutely examined, for, if the rollers are worn or improperly proportioned, they will completely destroy the steady and free movement of the healds. Put the crank on the top centre or a little forward or a little backward as the case may be, then put the treadles level against the tappet and fasten it. The tappet should be so set that the front shed will rise when the loom picks from the right-hand side in a left-hand loom, and from the left-hand in a right-hand loom. If there is anything wrong, either in the boring or the casting of the tappet, it will show a difference in the position of the healds, that is, when set level. One will be higher than the other, and this has a tendency to make the healds tight on one side and slack on the other. A faulty bore makes it impossible to obtain equal sheds, nor will both sheds be equal in time of operating. A tappet of this kind should always be discarded.

Lease Rods.

Between the healds and the back rest of the loom are placed what are known as lease rods. The chief object of these rods is to maintain the warp ends in correct relative positions as determined by the lease which is made when a warp is being gaited up at the loom. The presence of the lease rods keeps the ends from becoming entangled, and enables the weaver readily to find the correct place for a broken warp end and, after piecing it, to draw it in with the minimum of trouble. In addition, the lease rods influence the

shedding by forming, at the back of the healds, a definite position from which the shed is struck; the fell of the cloth forms the limit of the shed in front of the healds.

Lease rods are of two sizes, the smaller being placed in front. They are made of material that will stand the friction of the warp without having grooves cut in them, usually being made of wood covered with tin. The rods are pointed at one end to facilitate passing through the shed. Both oval and round types are in common use.

Back Rest.

The back rest in the manufacture of plain goods is made to oscillate in order that the part of the back rest in contact with the yarn may neutralise the variation of tension exerted on the yarn by the moving healds. The threads gradually go slack, when the healds are changing positions, until the shed is closed and then the tension upon the yarn is gradually increased till the formation of another shed, because the cloth has been drawn forward and the opening of the healds pull of a certain length of yarn from the beam. The oscillating arm which rests upon the oscillator must occupy its lowest position when the shed is fully opened, and its highest position when the shed is closed. But this arm is put out of action when any other weave is employed (such as, twills and dobby patterns without much of plain weave in them) because some healds will remain open for more than one pick, and all the threads do not assume one position when the shed closes. When fabrics are woven face down, the back rest is slightly dropped, and heald eyes raised to leave the bottom shed slack. For the purpose of obtaining cover on the cloth, the back rest is sometimes raised so that the bottom shed line of warp is depressed more below the warp line than the top shed line is raised above it, and that a greater tension is applied to the threads when at the bottom shed line—than when forming the top shed. When the warp of a plain cloth is drawn upon 4 shafts, two of which work together, it is better to enter the lease rods in such a manner that both sheds bind particularly round the rod nearest the heald shafts. The sheds are thus better equalised and better cover usually results by the two and two lease. Sometimes it necessitates to produce good cover in the cloth, a cord may be connected in the centre of the front lease rod, and after passing it over the heald roller shaft, attach the other end to the slay cap, the length of the cord being such that it just begins to raise the lease rod when the reed is about one inch from the fell of the cloth,

thus allowing the top shed to shaken a little. Some prefer setting the tappet such that the shed for the second pick is almost formed as the first pick is beaten up in order to avoid reedy cloth.

How to change plain to Twill Motion.

If a loom has to be changed from plain to twill motion, then remove the plain motion and put the twill motion in its place. Put the first and third treadles level to the tappet and fasten it. The second and fourth are sure to be right; set it so that the back shaft will rise first, the others will follow in rotation.

Shuttle.

The shuttle is about $1\frac{1}{2}''$ in diameter at its centre and thickest part, and about 12″ long. The shuttle should be perfectly square and in level to fit the race board and reed.

The shuttle is an oblong shaped hollow receptacle with pointed ends, used in the loom for carrying the weft backwards and forwards through the shed, so that it may be interlaced with the warp threads and form the woven cloth. In the hollow of the shuttle is fixed a tongue or peg, on to which the cop, or pirn, containing the weft is slid. The reciprocating movement of the shuttle is effected by the picking motion. The weft thread from the cop or pirn is passed through eyes in the shuttle, in order to regulate the tension.

Up to 1733 the shuttle was passed from side to side of the loom by hand. Then John Kay invented the flying shuttle.

The problem of the traverse of the shuttle in a loom is always a very fascinating one, but nevertheless, it is of the utmost importance if the intention is to get the best out of a loom. Here are a few of the factors which influence shuttle.

(1) Length of shuttle box and length of shuttle.
(2) Position of swells in shuttle box.
(3) Shape of box swells.
(4) Proper alignment of reed and box backs.
(5) Setting of picker and picker spindle.
(6) Type of shedding motion used.
(7) Type of cloth being Woven.
(8) Position of loom back rest and breast beam.
(9) Type of picking motion in relation to shedding

Choice of Shuttles.

The three principal kinds of wood from which shuttles are made are persimon, cornel, and boxwood, the prices increasing in the order given. The chief dis-advantage of persimon wood is that if it splinters it will not only cause a smash but will also be difficult to repair owing to its short grain. Cornel wood is less likely to split into small splinters, but when it does the size and extent of the split is generally such as to render the shuttle useless. African boxwood free from knots, well seasoned, and thoroughly dried, is undoubtedly the best wood for shuttles for both fine and coarse counts in warp. The only draw back to the more general use of this wood is its cost. The best shuttles are covered with a red fibre compound that sets very hard and is extremely durable. The first cost of these shuttles is high, but they have been known to last 10 to 12 years. The type of shuttle to use for different classes of yarn is a matter that calls for careful consideration. In the old type shuttle the peg has a square head hinged on a steel or wooden pin, and as these pins become worn, by the frequent lifting and lowering of the peg, the latter becomes loose in the shuttle and is then a common cause of breakages of weft. These breakages not only produce bad cloth, but also reduce the output of the mill. More recent types of shuttle have a spiral spring fited behind the head of the shuttle peg, so that as the pin wears the spring follows it up, thus holding the peg steady and giving much better weaving results, breakages being reduced to a minimum. The old type of peg has to be oiled frequently, and unless this is done carefully the oil gets on the yarn; it is almost impossible for this to occur with the new type of peg.

How to Determine the hand of Shuttle.

To determine whether a shuttle is right or left-hand, hold the shuttle with the top, which carries the larger opening, upwards. If, when in this position, the eye of the shuttle is on the persons' right, it is a left-hand shuttle, if on the persons' left, it is a right-hand shuttle. Right-hand shuttles are run in right-hand looms, and left-hand shuttles in left-hand looms.

In the construction of a shuttle, the back of the shuttle is made straight for a greater length than at the front. By this means more surface contacts with the shuttle box back and the reed is obtained. The shuttle is velled to an angle which is similar to the reed level.

The shuttle tip is set slightly to the front and a little below the centre of the shuttle. The object of this arrangement is to enable

the shuttle to force its way under any obstruction in the shed and is, therefore, not so readily thrown out. The further advantage obtained from a shuttle made in this way is that a slight bias is given to that side of the shuttle running against the reed. The V shape of the shuttle tip is recommended on condition that the sharp point is removed and made sufficiently smooth and round. If the point is rough it will break out the warp threads sometimes and so cause loss of production and bad weaving. This shape quickly ensures a corresponding recess in the picker, and is conducive to the shuttle being delivered in an easy and correct manner.

There are steel-pointed tips at each end of the shuttle to protect the shuttle and to present a smooth point to the yarn. It also contains a peg or tongue and porcelain eyes for the weft to pass through. The weaver sucks the weft through these eyes though this practice is unhealthy and liable to spread number of diseases. There are also self threading shuttles which do not give as good a result as sucking of the shuttle. The shuttle tongue should be smooth and straight. If it is rough at the ends and also crooked, it will spoil the cops when shuttling. If the bore at the base of a cop is closed, it should be carefully opened by the point of the shuttle tongue.

As a rule a weaver is supplied with two shuttles for the purpose of facilitating changes and allowing the weaver to refit the shuttle when the loom is in motion.

The end of the thread from the cop or pirn passes through the porcelain eye in the side near the end of the shuttle, so that by pulling the thread it unwraps from the cop or pirn with the greatest facility. It is very important that these two shuttles should be carefully gauged, both as regards weight and size, and shaped to the level of the slay. The size of the shuttle is limited by the strength of the warp yarn, because if the strain imposed is in excess of the elasticity of the yarn, more time would be lost in repairing the broken threads than would be gained by increasing the dimensions of the pirn or cop and shuttle. When the shuttle varies in size, it will be found either that the larger one will become jammed in the box or the smaller one will not raise the stop rod lever clear of the frog in the case of fast reed loom, whereas in the case of loose reed loom the smaller one will either fly out or cause a smash. If two shuttles of unequal weight are used in a loom, and if the pick is correctly set to the light shuttle, the heavy one will be driven with violence into the opposite box. But, if the pick is set to the heavy shuttle, the

light one will not reach its destination, consequently the loom will be continually knocking off when the light shuttle is in use. The weight of the shuttle should be such as will best suit the nature of the weft with reference to the drag.

When one of the weft yarns intended to be used on a check loom is coarser than the other, it is advisable to place it in a heavier shuttle of the same size in order to counteract the increased drag, otherwise as much drag as possible should be put on the finer yarn without causing it to break by placing a piece of flannel near the eye of the shuttle.

Shuttle and its Care.

The shuttle should always be kept in good condition. The chief points to watch are the spring and the pin which holds the tongue in position. A weak spring should be tightened or replaced by a new one. A worn-out pin should be removed out at once. Nicked eye in a shuttle should not be allowed. It can be turned to prevent the weft running in the nick rubbed down.

The shuttle box should be of a convenient length to enable one to check a shuttle in the most efficient manner so as to prevent any rebound from the picker, because if the shuttle does not come to rest well up against the picker one cannot be sure of a good throw in the next pick of the loom.

A shuttle box that is too short for the length of shuttle being used cannot check the shuttle efficiently. If certain fixed measurements are assumed to illustrate, and adopt a shuttle of 14 inches overall length and box plates of 20 inches, this gives plenty of length in the boxes to check the shuttle in an easy manner without having to place too much tension on the springs controlling the swells in the shuttle boxes.

The position of the swells in the boxes have a great effect on the checking of the shuttle, and also on the delivery of the shuttle from the boxes. A shuttle should be allowed to leave the box freely when the pick takes place, so if the swell is set too far back in the box it means that more force will have to be used to check the shuttle when it is entering the box, and this in turn means more force to get the shuttle delivered on the next pick. Apart from the extra strain that this would place on certain parts of the loom it does not lend itself to giving a good movement of the shuttle. If the

swell is set too near the front end of the box the shuttle is liable to be turned as it leaves the swell and so be given a zig-zag course across the slay. A shuttle that is not running straight is sure to place extra strain on the warp yarn.

When the shuttle is at rest in the box, with the shuttle tip against the picker, the centre of the swell should be about the centre of the shuttle. If one has a shuttle of 14 inches overall length a suitable length of swell would be seven inches, and this would then give one the centre of the swell about 10½ inches from the front end of the box.

The shape of the swell has a similar effect on the traverse of the shuttle as the position of the swell, and if the swell is allowed to project too far into the box with its centre position one shall not get good results. The swell should be constructed with a suitable easy curve on the side that faces the shuttle to allow the shuttle to enter and leave the box without a jerky movement. Proper alignment of reed and box backs, and also the plates at the bottom of the shuttle boxes and race board, are essential to reasonable shuttle traverse. Any obstruction from these sources will cause the shuttle to be deviated out of its true course. The shuttle guide, which is fixed to the box back over the swell, may be used to assist in keeping the shuttle down in its proper position in the box, but it should not in any way interfere with the free movement of the shuttle. Provided the shuttle is not too tight in the box it is not often necessary to fix this guide in a very low position, as the guide may also assist in keeping the picker to its proper path on the spindle for the greater part of its throw.

The setting of the picker spindle is one of the most important points in shuttle traverse, because on the setting of this depends whether the shuttle is tilted when it is released from the swell in the box. In single shuttle overpick looms the back end of the spindle is practically a fixture, but the front end is adjustable through the spindle stud.

When a shuttle is being drawn out of the box, the height of the spindle stud should be such that the shuttle is not made to fall from the picker at that end which is in contact with the picker when it gets to the end of the box. This can be tested by drawing the shuttle out of the box with the picking stick by hand. If the shuttle is allowed to fall from the picker when leaving the box, you can expect to find yarn from the warp damaged a few inches past the temple towards the centre of the race board, through the front end of the shuttle being tilted on the race board as it leaves the box.

Steeping of Shuttles.

(1) The shuttles should be steeped in $\frac{2}{3}$ pure raw linseed oil and $\frac{1}{3}$ boiled linseed oil or, two parts of finest boiled linseed oil and one part of arctic sperm oil. The reason for introducing sperm oil is that boiled linseed oil alone tends to thicken, and in that state it takes longer to penetrate the wood.

(2) The shuttles should be allowed to remain in oil for at least 2 months of persimon wood, cornel wood requires 3 months and box wood still longer.

The shuttles should be placed vertically in the steeping tank, with the eyes at the top, so that if there is any sediment it will not have to be cleaned out.

(3) The oil should be run off and the shuttles allowed to drip a day or two by rearing them up on tip ends. The longer they are allowed to dry, the longer they will last and the better the service they will give.

(4) It is then necessary for the shuttles and the tongues contained in the shuttles, to be well cleaned and freed from any surplus oil remaining on the shuttles. If this is not done effectively, the oil will solidify somewhat and make shuttles sticky if they are allowed to become sticky, it will cause a considerable amount of extra labour.

(5) The shuttles should then be stored away in some suitable and dry place and stocked in such a manner as to allow a free passage of air between one shuttle and another—in other words, the shuttles must not be packed close together, but a space left between each shuttle.

(6) When the shuttle is in use the spring must not be forgotten to be fed with a drop of oil now and again.

Specification for shuttles.

1. " SIZE."
   - (*a*) Overall length of shuttle in inches.
   - (*b*) Size on wood length = (1) Width (2) Depth.
2. " TIPS."
   - (*a*) Straight.
   - (*b*) Blunt.

3. "CLIPS."

(*a*) Common Wire.
(*b*) Narrow Iron ($\frac{3}{8}''$ or $7/16''$ Wide).
(*c*) Broad ($\frac{5}{8}''$ or wider)
(*d*) Special (Send a sample clip).

4. "TONGS."

(*a*) Single Spring.
(*b*) ,, ,, with collar.
(*c*) Tweezer.
(*d*) Do. with collar.
(*e*) Length of blade (exclusive of collar when fitted).
(*f*) Centre pin of wood or steel.

5. "EYES."

(*a*) Number of eyes.
(*b*) Design No.

Whenever possible send a sample shuttle and complete range.

Picking.

The second movement of a loom consisting of propelling the shuttle which carries the weft yarn from one side of the slay to the other in their respective boxes after the healds have been opened and a shed formed, thus leaving a pick of weft. This action of the loom is termed as Picking. It is a motion entirely different from any other movement of the loom, and is of so much importance that it necessitates serious observation and thought to obtain satisfactory working by setting the motion to pick with that force only as will send the shuttle easily from one side to the other.

If the shedding movement is mainly responsible for the quality of cloth produced, it is the picking movement that is mainly responsible for a good or a bad working loom.

The two chief styles of picking motions are the over-pick and the under-pick. The cone picking motion is commonly used for fast running looms weaving light, medium and heavy fabrics. It consumes less power, and is smoother in action and less liable to throw out the shuttle than under-pick motion.

Attached to the tappet shaft are picking plates or shells having concentric slots for bolts, and are bolted to picking bossess which are keyed upon the tappet shaft, one at each side of the loom inside of the framing. Both the picking boss and picking plate have teeth

(generally 96 teeth each) on their surfaces in order to prevent slippage when secured to each other. By altering the posiition of the picking plates the loom can be made to pick sooner or later, that is, the picking shafts is turned forward and backward.

There is at the end of the picking plates a picking nose or neb that rests in a groove and which acts on an upright picking shaft which has a cone-shaped antifriction picking bowl attached to it by means of a bolt and it (picking shaft) is placed outside the loom-framing as this gives most satisfactory results. The picking shaft is held against the loom-framing by a bracket termed the swan-neck bearing near the top and a footstep at the base. This footstep must not only be securely bolted to the loom framing, but fixed in the correct position.

The picking shaft must be free to turn in its brackets without undue friction. If the shaft binds at all there will be a weaker pick.

Too little pick is as bad as too much pick, in the first case the shuttle does not get home soon enough, and in the second it gets there too soon. A jobber may have a loom with too much pick at one end, the effect of this can not only be heard, but can also be felt by placing a hand on the box at the side affected. This fault occurs mostly when a new picking neb is put on a loom. It is not wise to run a picking neb for too long a period, and when it begins to show definite signs of wear, it should be replaced by a new one. Many weavers in putting on a new picking band, get the band either too tight or too slack; this is simply a matter of adjustment. Faulty picking may also be cured by either tightening or slackening the check strap.

The picking neb is removable and is lengthened in broader looms about 5/16 of an inch for every 10 inches wider reed space. The nebs that are used for various widths of looms are as follows, and which should carefully be noted :—

Width of looms.	No. of neb.
28″ to 32″	0
36″ to 40″	1
46″ to 56″	2
58″ to 100″	3

The picking may become the source of considerable trouble. But to obtain successful results the following parts, namely, the

shuttle, the race and the nature of the pick to be given to the shuttle, should receive spec al attention.

Width of looms.	Length of picking stick
28″ to 54″	21″
56″ to 72″	22″
74″ to 78″	23″
80″ to 100″	25″

The above is for upto 10″ (28″ looms) crank arm and for every 2″ longer of crank arm, one inch should also be increased in the length of picking stick.

Picking must be timed in conjuction with the shedding. The picking cams should be so set that the picker commences to move the shuttle when the cranks are 60 degrees past front centre position or about 30 degrees from bottom centre position. On no account should the effective stroke of the picker continue until the buffer is reached, otherwise the picker and the buffer will be quickly smashed. When the picking nose-piece finishes its stroke on the picking bowl, the shuttle has reached its maximum speed and the picker should then be at least an inch from the buffer.

Picking Stick.

Choice should be made of picking sticks 1½ or 1¾ inches on the square and tapered down to ¾ or ⅝ of an inch, made from ash or such like wood, because with such a stick a quick sudden blow is given to the shuttle in the form of a whip lash with one or two waves in the picking band, and the picking stick will then return to its former position without frequent rebounding. To ensure that the picking stick is of proper length, put the crank on the front centres, draw the picking stick over the middle of the spindles, and the centre of the picking band, where it leaves the picking stick, should be over the spindle centre.

The picking stick is attached to the picking shaft by means of two tops both having a similar radiating teeth on their surfaces and fits one into another. The bottom top has a square hole and it rests on the picking shaft. The upper top which has a groove on the top is for the picking stick to rest in. A cap is placed on the top of the picking stick, then the whole thing is fastened by means of a nut. The teeth also of the square hole in the bottom top and the round hole in the upper top help to form a rigid connection and facilitate adjustment. As the tappet shaft revolves, the picking neb together

with the picking plate and the boss revolves, and whilst revolving, strikes the picking bowl which partly rotates the picking shaft and the picking consequently causes the picker to strike the shuttle with sufficient velocity to drive it across the loom. The picking nebs oppose each other when they are in a vertical place, that is, one is above, the other below the shaft centre. As has already been stated above that there are slots in the picking plate and it is fastened to the boss in the centre of these slots, so that it can be made to pick either sooner or later, and the picking neb set as near the end of the bowl on the picking shafts as possible to give a gentle and easy pick, and the bowl on the picking shaft should be set so that the centre of the picking bowl stud be to the height of the outer rim of the picking plate, and the full force of the blow delivered when the extreme picking neb is in contact with the antifriction bowl at a point directly opposite the centre of the picking bowl stud. Should this not be observed the wear of the bowl and neb will be irregular, and the bowl itself will be subject to occasional stopping, either from want of oil, defective setting or a short picking band, a flat place will very quickly be formed on the bowl. Therefore the bowl will sometimes be stationary and, at other times, in a revolving condition, thus making it impossible for the pick to be uniform or equal in power under both conditions. One ought to ascertain whether the surface of the picking plate and its attached neb are operating on the whole surface of the bowl during the entire revolution of the tappet shaft.

Adjustment of the Antifriction Roller or Picking Bowl.

If the picking bowl stud (which is placed in a slot in the picking shaft, so that an adjustment is made easy) is placed too high, the stroke of the picking stick will be shortened, the force of the pick lessened and the antifriction bowl liable to run off the rim of the picking plate. If it is placed too low, a considerable amount of the strength of the blow is wasted in trying to force the stud downward as a harsh, jerky movement is the result which can be seen by mere cursory observation. The key should be fast in the boss, also all nuts and studs secured. The picking plate should be so set as to strike about one inch before the crank gets to the bottom centre. The picking stick should never be allowed to go too far back, but it should be about two inches from the end of the sley. If a stronger pick is required, then draw the picking stick a little towards the inside of the loom and if weaker pick is required, then do it *vice versa*.

The picking bowl is kept in contact with the picking neb by attaching one end of a spiral spring to any convenient part of the framing, that is, to picking shaft spring bracket and the other end to a collar upon the picking shaft. The spring causes the picking stick and the picker to move back after the delivery of each pick. The forward end of the shuttle gets lighter and lighter as the weft is drawn out and, thereby, the centre of gravity is constantly changed, hence the method of propelling the shuttle becomes difficult. If there is any obstruction in the way of the shuttle, it will be more liable to divert a light shuttle than a heavy one. If an empty shuttle is not heavy enough to overcome every resistance and draw weft close to the selvedge of a fabric, the risk of flying-out will be great. A heavier shuttle should be employed for a coarse than for a fine weft. Because when passing through a shuttle eye, there is greater tension upon a coarse than upon a fine thread.

A very great strain together with considerable wear is brought on the loom on account of the picking movement. Pickers, picking band, shuttle check-strap and all other parts connected with it are constantly wearing out or breaking. If the best of care is not taken, the cost for these supplies will be very large item of the shed stores.

Buffalo Pickers.

The buffalo hide picker or buffalo picker is a small arrangement made of raw buffalo hide and it is a buffer to deaden the force of the blow or concussion. It is attached by means of the picking band connected to the picking sticks. The picker is freely mounted upon a spindle placed over the box centre throughout its length.

The spindles should be continually wiped and lightly oiled particularly when starting after an interval and in the morning. The pickers should be kept scrupulously clean in the spindle hole, underneath, on top, and at sides, so that there is not the least chance of dirty oil or fluff being thrown into the cloth. This will also help to make the loom run better. Everything about the shuttle boxes should be kept very clean.

Pickers should be of good quality, well-seasoned, of equal weight and made from as few pieces as possible. A light picker is usually a very dry one. They should be thoroughly conditioned after their receipt at the mill.

Few appreciate the enormous amount of work performed by a picker, and it is subjected to such rough usage in operation, that unless it is manufactured on sound principles, and from well prepared materials, its profitable life is so short as to make frequent replacements a costly procedure.

Seasoning of Pickers.

(1) Pickers should be hung up in a perfectly dry place for three months before putting into oil, in order to season the hide thoroughly. Pickers should, on no account, be put into use if they possess the appearance of being in a state of approaching absolute dryness, when pickers are used in this condition they are liable to break rather than wear.

(2) They should then be placed in oil (arctic sperm) for a minimum period of six months, only the best southern spern oil should be used.

(3) Steeping tanks should be fitted with false bottoms, so that the pickers do not come into contact with any foreign matter which may settle in the tank.

(4) On being taken out, the oil should be allowed to drip off the pickers, and they should then be hung up for a further period of at least three months.

(5) Remember that the longer the pickers are seasoned, the better will be the service which they will give. But special care should be taken that they are not kept in a damp place or exposed to a damp weather.

(6) The swell spring and the shuttle guide of the box should be so adjusted that the shuttle must strike the pickers in the centre. Where this is not attended to, the shuttle goes on striking the picker side ways and the best pickers are broken in a short time and the consumption rises abnormally.

Moisture is the greatest enemy of pickers and so particular care should be taken to see that they are not in the least exposed to the same, as leather has great affinity for moisture, water is readily absorbed and the life of pickers is adversely affected. Mineral oils are very harmful to pickers as they ruin the natural grease of hides thereby making them dry and brittle.

Generally pickers weigh about 76 to 90 pounds per double gross and the weight to be preferred for a particular loom depends on the size of the loom and the weight and the size of shuttle used.

If the loom is wider, (such as a blanket loom etc) heavier pickers should be used, and vice versa. Pickers weighing 80 to 82 pounds per double gross are in popular demand.

Previous to pickers being used on the loom, they are occasionally bored with an ordinary brace and taper bit, just sufficient to permit freedom of movement of the picker on the spindle.

It is better not to rimer a picker. This is a very unsatisfactory method, especially if the taper of the bit is very acute. The bit must be forced far enough to clear the inside of the socket, the outside will then be too large for the spindle and thus the pickers are weakened near the holes and they break from this place, before giving its full life.

The pickers must slide freely from end to end in the slot provided in the slay plate at the bottom of the shuttle box.

The side of the picker should be readily changed when a little less than half of it is picked. Heat is generated by the constant friction of the picker with the spindle and so a little oil must be applied to the spindle off and on. This prevents the Spindle from being very hot and the hide of the pickers is not damaged by heat which would make it dry and brittle.

Unless the pickers are designed and made to a degree of accuracy which almost seems unattainable in this world, the shuttle leaves the race-board altogether and flies out, both on leaving and on entering the box. Moreover, let the picker be the least bit out of true, unbalanced on the spindle, ill pressed in the making, and the picker will drive itself into the nose or leaf of the shuttle, causing it to fly upwards and outwards, always with the possibility of disfiguring for life the weaver in the near vicinity of the loom.

Buffers.

At the termination of its inward movement, the picker is prevented from striking the spindle stud by placing a buffer on the spindle. If the picker were directly to strike the stud the former would soon be broken and become unfit for use. Of the various forms of buffers used on over-pick looms, one type consists of U—Shaped sections of leather, one fitting inside the other and the whole rivetted together at the upper ends. On each side a short strengthening piece is fixed. The buffer is punched so that it can be threaded on the spindle.

Picking Band.

Looms, that are fitted good picking band, are of equal importance with good pickers. The picking band should be well conditioned before being used. Because there will be less stoppages for repairs and it is cheapest in the long run. The picking band should be dry and not spongy. If a hard, thick and stiff band is used, then it refuses to cling to the stick and works like a spiral spring with the result that it picks unevenly, and is troublesome.

The most expensive leather used on a loom is the picking band. Attention to worn picking sticks will save a considerable amount in bands, and a new picking stick is much cheaper than a band.

The picking band is fastened to the picker by passing one end of the band through its slot, which should be free from sharp edges and secured by forcing a leather peg through a hole in the picking band, which is prevented from slipping out when working. The other is twisted round the picking stick spirally and wire pin is driven into it (picking stick) and passes through one of the holes to retain the band in position. A wire staple, or a strip of leather screwed to the end of the picking stick, bridges the ring groove that accommodates the band in its place. This groove should be quite smooth.

Great care ought to be exercised to allow the correct length of the strap between the picker and the picking stick, such that when the crank shaft occupies back centre, if the picking stick be moved inwards by one's hand, there will be a gentle sideway and a bottom pull of the picker along the spindle without the strap being unduely slack ; and by moving the picking stick backward and forward, a picker should slide freely from end to end of the spindle. After adjusting the correct length of the band, work the crank over, and when the picker has reached the extent of its traverse on the spindle, it should be possible to place two or three fingers between the picker and the buffer when the picking bowl is at its maximum outward movement. If the strap is made tight above a certain point, there is not only a great strain put upon the picking strap, but the power of the pick is also weakened by the friction of the picker upon the spindle. The picking strap is always more or less slack when the picking stick is in a state of rest, and the picker, being only partially pulled back, requires the shuttle to impinge against it to complete its backward traverse.

A picking band generally breaks near a picker, a long band, therefore, is advocated as it enables one to cut the damaged part and unwind a portion from the picking stick. A fresh hole may be punched or the hole may be punched before the band is put in position $\frac{3}{4}''$ apart, and the band again secured at both ends as before. The shuttle under ordinary circumstances begins to move out of the box when the crank is at its bottom centre, and have received its final blow by the time the crank is half-way between the bottom and back centres, because between this point and a point half-way between the back and top centres, the sley is travelling very slowly and the reed is drawn to give full advantage of the open shed. It is advisable to time the picking a little earlier as more time is allowed by so doing for the traverse of the shuttle and the pick can be made a little weaker.

Picking early should accompany shedding early. Early picking would be when the shuttle entered the open shed just before the crank reached its bottom centre, whilst late picking would be when the crank had passed its bottom centre, and the shuttle is entering the shed.

Badly timed loom usually results in breakages of the warp, stitches looped or fringed edges, flying shuttles, knocking off the loom, shuttle catching in the shed, broken cops, and excessive wear and tear of the loom.

Shuttle Box and Check Strap.

There is a relation between the length of the shuttle box and the length of the picking neb. If the picking neb is a short one the shuttle box must be short, and if a longer picking neb be used (the leverage of the stick, etc., being the same) the shuttle box will be longer. A long shuttle box is also an advantage, as by guiding a shuttle, it reduces any tendency to fly out. The amount of power required for picking is effected by means of the swell and the amount of pressure it exercises upon the shuttle. The back of the box should be parallel with the reed except for the projection of the swell and the shuttle guide should be set a little wider at the opening than at the end. It is usual to set the mouth of a box at least $\frac{1}{8}$th of an inch wider than the rear end. The shuttle is kept steady and prevented from rebounding in the box by means of a check strap without which the shuttle would become jammed at the end of the box, and the picking would be jerky. The check strap consists of leather strap one inch wide and of equal length with a sley. It is

supported by four guiders which are secured to the sley front. It is permitted to partake of a sliding motion at its centre; a piece of leather half inch long by one inch wide is nailed to work between two centre guides that allow three and half inches traverse in the check strap. It is connected to the spindle by means of a leather 6 inches long and $1\frac{1}{2}$ inches wide. A hole is punched on one end to work on the spindle and a slot along the breadth of the check strap cut in the other end to fasten it to the check strap with a piece of wire to act as a buckle, so that the check strap can be lengthened or shortened as required. If the check strap is too short, the shuttle will not get far back in the box, and when it is too long it is practically useless, as the shuttle will rebound. A short check strap will also cause the cops to break and the weft to slip off the bobbin by stopping the shuttle too suddenly. Two pieces of leather called guards are about $1\frac{1}{2}$ inches broad by 5 inches long, and punched at both ends. One end of each is pushed on a spindle in front of the buckle, the other goes beh nd the box end and is secured to it by means of a box end spring.

To adjust the check strap place the cranks upon their bottom centre, and when one picker is at the box end, tighten the check strap until the remaining picker is slightly more than one inch from the end of the other box. If the check strap does not prevent a shuttle striking against the box end, the shuttle will rebound and cause the yarn to slip off the cop or the bobbin if built soft.

Great care should be taken to see that check straps are not rubbing and wearing on the staples, and the same care should be observed regarding buffers, etc., on the spindle and against the spindle stud.

Strong Loom Sundries.

All loom sundries should be stored systematically, thus saving time and preventing stocks being exhausted and looms being stopped in consequence. Small castings can be stored in compartments fitted with shelves, so that no time is lost in finding them, and the number in stock can be ascertained without any sorting out. The store room should be kept very clean and dry and there must be plenty of light in the store room.

Change wheels should be stored either in or near the weaving shed, each shelf or compartment bearing in plain figures the number of teeth in the change wheels it contains. Jobbers should be strictly instructed to return all spare change wheels instead of leaving them lying about all over the shed.

All castings should be examined carefully when they are delivered to the mill, and all rough or unfinished castings rejected. The most common defects in castings are blowholes, which can be detected only when they are near the surface. In such cases the indication may be merely a small pinhole, but if this is probed with a piece of thin wire it will generally reveal a cavity under the skin of the casting, where a breakage is likely to occur. Blowholes are also indicated by a small circular glossy patch on the otherwise dull surface of the iron, and if a blowhole is present it can be exposed by tapping the bright patch with a hammer or the edge of a file. Wheels are usually the weakest parts of a loom, and should receive particular attention when new looms are received, so that defective wheels may be replaced . In such cases loom sides should also be tested for the same fault. All castings are liable to be cracked in transit, but this is a defect that can be very easily detected by suspending the casting and tapping it with a hammer or spanner to see if it rings true.

Shuttle Guards.

Shuttle guards are a simple appliance of various kinds fitted to a loom's sley cap to prevent the shuttle flying out and causing accidents to the work people.

Though these shuttle guards do not entirely prevent the shuttle from flying out, but they do serve to keep the shuttle from flying out very high and injuring the weavers in the upper parts of their body.

The distance between the guard and the reed cap should be slightly less than the width or depth of the shuttle, so that if the shuttle rises it will strike this rod, and either be turned into the yarn again or run over the yarn until it strikes the opposite shuttle box. Thus, the accidents are minimised.

How the Shuttles Fly or Rattle in the Box.

The shuttle flying out of the loom is caused generally by some obstruction in the shed.

If the sley stands higher at one side than the other, the spindle studs stand too low; top of shed too low or bottom too high, the loom picks too late or too soon, or too strong, or the picking point be loose, or the picking bowl be loose, or dropping too low, projecting reed or some of the dents stand out so that the shuttle has no clear

passage, floats, fibrous yarn, knots with long ends, the edge of the temple nearest the reed stands too high or the race board be badly worn out or it stands higher than the plates in the box more particularly at the fork side, the back-board badly worn out, swells that give a twist to the shuttle as it leaves a box, the shuttle be crooked or the tips striking too low in the picker so as to cause the shuttle to raise at the other end; or by a crooked spindle or spindles dry dirty or broken pickers, two odd shuttles, the shuttles are not in proper level with the sley; the tappets getting loose and causing the sheds to rise too late or too soon. A rocking shaft that allows the slay to lift. All the above causes have a tendency to make the shuttle fly out, turn over, or rattle in the box.

When the Shuttle Rebounds in the Box.

The shuttle rebounds in the box if the loom picks too strong or too late; the picking bowl be loose, or too low; the picking point strikes with too great a force; the check strap does not work freely, the shuttle has too much play in the box; the spring which presses against the swell be broken or too slack.

Causes of Loom Banging-off.

Irregular speed of line shaft; too thick, hard, and dry leather belting; slack driving belt or bad lacing; full width of belt not on the fast pulley; belt guide too wide for the belt: oil on belt or pulley; loom not fixed firmly to the floor; brake not releasing the fly wheel instantly on starting the loom; inaccurate timing of the pick; shed not large enough to clear the shuttle; stop rod bearings loose; sley swords twisted; slight looseness of either rocking rail, sley sword or crank arm; swell spring excessively tight or very slack.

When the Loom Knocks off.

The loom will knock off if the picking plate is loose on the boss: the loom pick too weak, the picking stick is loose; the tumbler boss is not either too late or too soon; the fork is strained so that it touches the sides of the grate, or it stands too high and touches the top of the grate, the loom will stop when the weft is not broken and not stop when the weft is broken.

Sley.

The sley is a beam of wood (pine) carrying a reed, and having a reciprocating motion to and from the fell of the cloth, imparted to it by the cranks or the crank shaft which is the prime moving factor in the loom, from which all other movements take life. The beam

is supported on two vertical rods called sley swords attached near the bottom of the loom to a vibrating or rocking shaft. The shuttle race, which is the part of the sley in front of the reed and resembles a shelf upon which the reed is supported, is made of hard wood (daroo wood) laid on the beam, and in addition to the depression at the centre is also rather wider at the middle of the race at that point but giving out slightly against the reed.

The nature of the movement imparted to the sley is such that the shuttle should have every point in its favour during its passage across from box to box. The movement of the sley is not conducive to the desired result, this being due to the following circumstances:—

> The sley first begins to move backward, then remains stationary for a short period, while the crank is turning the back centre and then begins to come forward. When to this variable movement is added, are other pssible discrepancies, the importance of a true race is apparent.

One of the many causes of "flying shuttles" is the sley being out of the truth, and this defect may be traced to some of the following :—

> (1) The angle formed by the race-board and sley not being exactly the same as the bevel of the shuttle; (2) the sley and back of the shuttle box not being in alignment; (3) the race and bottom of the shuttle box being out of truth, and especially in box looms. Whenever the shuttle begins to work unsatisfactorily the race should be tested. This is usually done by means of a straight edge which is first placed at the entrance of the shuttle box testing the sley with the back of the box, then the race with the bottom of the box or sley plate, if a box loom, each box should be tested. The straight edge is next run across the reed, as it sometimes happens that this is found to be defective. This may be due to a bulge in the reed, or to some hard substance accidentally getting into the groove before putting in the reed when starting the loom. The angle formed by the race and sley may be tested by means of a plumb line stretched tightly across the sley from the back of the shuttle boxes and comparing extreme and corresponding measurements.

Shuttle Box.

A shuttle box is fixed at each end of the shuttle race, which receives the shuttle as it is shot from the box on the opposite side. The construction of the shuttle box is a factor which exercises considerable influence on the passage of the shuttle. If the shape or the construction of the box is faulty, it naturally follows that the commencement of the passage of the shuttle will also be faulty. The nearer the boxes assume a rectangular form and are free from swells and the action of their springs, the more efficient are they in their working.

Box Plate.

The box plate at the bottom of the shuttle box should be at least five to six inches longer than the shuttle that is being used, as this will give a reasonable length in which to check the shuttle.

A shuttle box can be too long as well as too short but it has quite a different effect on shuttle traverse. A shuttle box that is too long appears to have very little control over the shuttle and unless it is reasonably controlled while leaving the box, it can play all kinds of tricks before it reaches the opposite box.

Adjusting Shuttle Boxes.

Before adjusting the shuttle boxes to satisfactorily accommodate the shuttle, and also in the adjustment of the lift of the stop rod blade, it is essential to see that the pair of the shuttles are accurately tried on any patent trimming machine to ensure that they are of equal height and breadth, that each shuttle spins round in a true manner when placed on the extreme ends of each tip, that the back of the shuttle which runs against the reed and the bottom of the shuttle is similar to the reed level, that the underside of the shuttle which makes contact with the race-board is like a perfect plane or better still, and slightly concave. The groove in the front face of the shuttle should be at the same height as the corresponding groove on the inner surface of the box front so that the weft may not be damaged, and also that the distance from the shuttle tip to the bottom of the shuttle is the same for both the shuttles, otherwise both shuttles could not make contact with the picker at exactly the same height, and lastly both shuttles applied to any one loom must be equal in weight as near as possible otherwise trouble will follow with the picking motion.

Shuttle Box Swells.

The position of the swells in the boxes has an effect both on the checking of the shuttle and the delivery of the shuttle as it is leaving the box. If the swell is too near the back end of the box more force has to be exerted to check the shuttle as it enters the box, which in turn means more force to get the shuttle moving again out of the box. On the other hand, if the swell is too near the front end of the box it will be an easy matter, to check the shuttle, but consider the difficulties that it will create to get the shuttle out of the box again, as the shuttle will have to be forced round the curve of the swell. Again, apart from the force that has to be given to the pick to get the shuttle out of the box, the shuttle is liable to be turned as it leaves the swell and so be given a zig-zag course across the sley.

When the shuttle is at rest in the box with the shuttle tip in contact with the picker, the best position for the swell is to have the centre of that portion of the swell that projects into the shuttle box exactly in the centre of the shuttle. This should give good shuttle checking, by allowing the shuttle to be brought to rest without any sudden shock and also allow the shuttle to be started on a straight course for the next pick, less tension can also be applied by the swell springs as the swell will have a better chance of holding the shuttle steady in the box. The shape of the swell has a similar effect on the traverse of the shuttle as the position of the swell, in that if it is not constructed with that easy suitable curve, it will have to project too far into the box to check the shuttle. This means that the shuttle, as it leaves the box, will have to be forced round the corner, as it were, and so be given a jerky movement.

Proper alignment of reed and box back, and also the plates at the bottom of the shuttle boxes with the sley cannot be emphasized too strongly as any obstruction from these sources will have a tendency to deviate the shuttle from its true course. The setting of the picker spindle on an overpick loom is very important as an aid to good shuttle traverse, because this will determine whether the shuttle is given a straight throw after the shuttle has been released from the swell. In single shuttle overpick looms the rear end of the spindle is usually a fixture, but one can adjust the front end, through the spindle stud, to suit the purpose. It is quite a customary practice to incline the spindle slightly from back to front, but the important point about this inclination is not a question of how much a spindle should be inclined, but of the height of the picker

spindle in relation to the shuttle, when the picker is delivering the shuttle at the end of its throw. It is preferable that the shuttle is not allowed to fall at that end which is in contact with the picker as it is leaving the box. This can be tested by hand by drawing the shuttle out of the box with the picking stick. If the shuttle is allowed to fall from the picker when it is leaving the box one may expect to find the warp yarn damaged a few inches past the temple towards the centre of the race board, through the front end of the shuttle being tilted on to the race board as it leaves the box. This will also cause the shuttles to wear badly on the bottom near the shuttle tips.

Tight and Slack Shuttle Boxes.

Too tight a shuttle box may be the cause of the shuttle flying out; whilst, if the box is too slack, the shuttle will rebound and cause the loom to knock off, or the shuttle may be trapped in the shed. Tight shuttles are very frequently the cause of the boxes not working satisfactorily. If, when the boxes are being lifted or depressed, the tip of the shuttle comes in contact with the picker, and the shuttle is held unduly tight in the box, it is unable to slide forward clear of the obstruction and so prevents the boxes from working.

Shuttle Trimmer.

It is a cast iron frame work capable of receiving a pair of the shuttles at a time. The upper surface of the frame work is planed to receive a sliding cutter, which, as it is moved backward and forward, pares away a thin layer of the wood leaving the shuttle with a smooth surface. The trimmer can be fixed to a table. A proper angle ensured the shuttle while in the casing.

Importance of Sley.

There is no part of the loom which is of greater importance than the sley for controlling the shuttle during its flight from box to box. To set it properly requires great care in order that the loom may be made to weave well.

There are three most essential factors to mind if the sley has to accomplish its dual purpose satisfactorily ; namely, level, concavity and convexity. Set the sley sword that they will stand two and half inches nearer the loom front at the bottom than the top when the crank is on the top centre.

Sley Swords.

Previous to attaching the sley to the loom the swords should be examined carefully by placing a level of 90° on the bed which is cast on the sley sword and the front part of the sword, on which the sley itself will ultimately rest. Before bolting the sley swords strike a chalk line on level floor near at hand, and place the legs of the sword on this line and glance along the sley. If the swords be found out of line, they must be pared out at the bow springs until the sley swords all lines up. When fitting the sley in the loom, bolt one side first, in all probability, the opposite sword will be found well away from the rocking rail. If this end is bolted up the sley is given a decided twist which may cause endless trouble; the remedy is to take off the faulty sword and pare out the wood until the swords line up to the rail without pressing. In order that the movement of the sword pin may be equal to the throw of the crank, and that the forward and backward movements of the sley may correspond as closely as possible, a line drawn through the extreme positions of the sword pin should also pass through the crank shaft centre. After the arms are connected to the sley swords, the swing rail brackets are adjusted on both sides so that the reed at the beat up will never be any further forward than a vertical plane passing through the centre of the rocking shaft. If the reed is allowed to pass this point the result will be that instead of the reed meeting the cloth at right angles to the warp line, thereby giving a smart blow to the weft, the cloth will slide down towards the bottom of the reeds. The height of the sley is largely determined by the amount of the cover required on the cloth. In all cases the cranks are on the top centres, a line extending from the back rest to the breast beam, should reveal the height of the sley as being lower than the line referred to, in order that the bottom sheds may operate efficiently and produce good cloth. The sley is now set to a spirit level with the crank on the front centre; after gaiting a new warp the crank is turned on to its bottom centre, and the slope of the race board is made similar to that of the bottom line. When the requisite height of the sley has been obtained to produce cloth satisfactorily, gauges should be made to assist in fixing the height of the sley should it ever become loose or be disturbed owing to momentum and banging off. For Henry Livesey's loom, the height of the wood block is 3½″, the gauge is placed between from under the sley box and the loom frame. When the crank is on its top centre, and with the crank in this position the race board is 1½″ lower than the breast beam. It has been found advantageous to have the groove in the sley and also in the sley cap shaped similar to

V instead of the ordinary round groove. This shape of groove will secure both old and new reeds in position without damage during beating-up. Further, it obviates the necessity of having resorted to the bad practice of packing the reeds at the end top or bottom to prevent its movement or slack fit in the round grooves. The reed ought not to be freed to make a slight lateral movement in order that it may adjust itself to the position of the warp as it produces bad results when applied in practice. Run a steel rule edgeways across the reed to see that no dents are projecting in the shed and whether the reed flushed with the shuttle box back. Set the sley level and the race board one and a half inch below the breast beam on the front of the loom.

The slide of the sley which is fastened to the front part of the sword, and the race board on which the shuttle travels during its passage from the one box to another are levelled to an angle of about 92° to prevent the shuttle taking a diverted course owing to the pick operating during the approach of the sley to the back centre. The sley is said to be properly set when the race board and the reeds are in exact level with the shuttle. The reed level is the angle formed between the reed and the race board, when the former is mounted in position for weaving. This level is at an angle about 88°, when the sley swords and the sley are correctly adjusted. The box back should, after being bolted to the sley by the spindle stud, make an angle equal to the reed level. The concavity which occurs on the race board will now be briefly referred to. The race board on which the shuttle travels in its transit from box to box is very slightly concave, the reason being that a picker travelling on an inclined plane elevates the rear end and depresses the forward end of a shuttle, and by so doing counteracts the tendency of the shuttle rising from the race board during its passage through the shed. On 40 inches reed space loom, the concavity is $\frac{1}{8}$ to $\frac{1}{4}$ inch when measuring from end to end of the race board.

The convexity of the race board occures at that portion which makes contact with the reed when the latter is in position. This assists in further reducing the chances of the shuttle flying out or being diverted from the reed by permitting the shuttle to continue moving in a downward and backward direction until the centre is reached, and by that time much of its energy will be expended. The allowance for the convexity is generally equal to the concavity. In looms of greater reed space increased allowance in both convexity and concavity is, of course, adopted.

The reed in a loose reed motion has one of its upper rib pushed into a groove in the sley cap. The bottom rib of the reed is supported and pressed against an iron bar which extends across the sley by the action of series of stop rod arms which are fixed upon the stop rod. An additional arm furnished with an adjusting screw is also secured to the stop rod. By pressing against the rear of a sley sword this screw regulates the pressure of the iron bar upon the reed. The stop rod has two curved duck bills set screwed upon it at equal distance from the swords. As a sley moves forward the ends of the duck bills are carried against the upper or lower faces of two edge-shaped heaters which are held rigidly by two heater springs bolted to the framing. When in its driving position, the starting handle holds a buffer facing the knocking-off fingers upon the stop rod but normally the knocking-off finger is below the corrugated surface of the buffer. Outside the end framing, an organ handle upon the stop rod carries at its extremity an antifriction roller (organ handle bowl) as the sley falls back, the organ handle bowl makes contact with a bow spring bolted to the framing.

Organ Handle.

The duty of the organ handle bowl and the bow spring is to steady the reed as a shuttle moves across the warp, that is, whilst the crank travels from the bottom to a little past the back centre. The light spiral springs are attached to hooks on the stop rod and the sley sword respectively. They hold the reed steady when the organ handle bowl and the bow spring are apart, but they permit the reed to yield to any unusual pressure, for instance should a shuttle be trapped in the warp. If this spring were very strong the warp would suffer before it would give way so as to liberate the reed, and if it were not strong, it would be impossible to beat much weft into the cloth without some other arrangement.

The Duck Bill.

To accomplish the beating-up, the duck bill tips will, when the reed and fabric are in contact, have passed beneath the heaters 7/16". This will vary as cloth varies as regards fineness or thickness. The duck bill should be set as fine as possible so that they will not get over the heaters instead of under. The nearer they can be got this way, the firmer will be the reed when it strikes the cloth. The springs should be set so tight that they will keep the reed steady when the loom is working. When the cranks are on the top centres, allow about two inches of play between the duck bills and the heaters, so that when the shuttle is trapped, the warp resistance will be

sufficient to stretch the spiral springs, force back the reed and cause the bar to lift the duck bills upon the upper slopes of the heaters. The knocking-off fingers should then strike the buffer and knock off the handle from its driving notch. If the buffer and the knocking-off fingers are not properly adjusted to each other the reed case will liberate the reed before contact is made between the buffer and the knocking-off finger. In that event, the knocking-off finger will sink below the buffer without pushing the handle and the loom will continue in motion until the weft fork causes it to stop.

Duck-bill rods must be kept well oiled. Generally speaking, a loose-reed loom can be run faster than a fast-reed loom, and here loose reeds are in use the weaving master should insist on the duck-bill rods being kept well oiled. Unless this is done the oil holes become clogged up with dirt, and if neglected by the weaver will lead to as big a smash, if the shuttle catches in the shed, as would occur under similar conditions in a fast-reed loom. The stop-rod tongues and frogs need frequent inspection in order to avoid the risk of the tongue slipping over the frog or missing it entirely when the sley is moving forward.

Types of Shedding Mechanism.

With reference to the type of shedding mechanism used, it is easier to get good shuttle traverse when the positive part of the mechanism is drawing the shed towards the race board and not away from it. Inside treading motions are this type, whilst cross rods, dobbies, and Jacquards, draw the sheds away from the race board and give one a negative bottom shed, which, when the cloth being woven is of the heavy type, seldom gives one a bottom shed line where the yarn rests on the race board. The height of the back rest and breast beam both have an influence on the manner in which the bottom shed line rests on the race board, therefore they must have some effect on the shuttle traverse more so when one is using a negative bottom shed shedding mechanism. In some cases it may only be very small, but it is wise to take advantage of it, and any alteration in the setting of these parts should be carefully watched if one desires to have the best condition for shuttle traverse.

It is fairly safe to assume that cloths which require the back rest and breast beam high are generally woven with a positive bottom shed arrangement combined with the plain overhead type of roller reversing motion, as one only requires high back rests for such

purposes as getting cover on to plain cloths or to assist in putting picks into cloth easier and in cases like these one has to make a good bottom shed. The timing of the picking motion must depend largely on the timing of the shedding motion, because, unless these two work in harmony one cannot hope to get reasonable results.

One must not lose sight of the fact that a shuttle must not enter the shed until the sley has moved back to that position where it allows the bottom shed line to rest evenly on the race board, as it must be borne in mind that the timing of the sley has not been altered. Although a shedding arrangement can be timed early the bottom shed line cannot rest on the race board until the sley has moved that distance away from the fell of the cloth to be at the position where the race board and the bottom warp line are at the same angle. Hence, unless one aims at making a shuttle enter the shed at this point one is liable to get damaged yarn, worn shuttles, and probably have to provide more power to drive the shuttle across the sley, which only reacts on the good running of the loom.

Reeds.

The reed has three important functions—(1) it beats up each pick of weft, which lies in the open shed after picking, to the fell of the cloth; (2) it separates the warp ends—singly, in pairs, or in some other small number, and maintains them in the correct positions throughout the entire width of the fabric; and (3) in conjunction with the race plate it forms a guide for the shuttle in passing through the shed from one shuttle box to the other. It is essential that the reed should be perfectly straight with the back of the box.

Beating-up.

The third movement is to beat up the weft close to the pick last inserted so that each succeeding pick becomes part of the cloth. The object of this motion is to control the going part or sley of the loom.

The sley serves the dual purpose of beating up the weft when in its front position (that is, when the shed is full open, and the warp threads are held at the tightest) and provides a ready medium, when in the back position, on which the shuttle travels from box to box. The pick of the weft, often being put through the shed, is at a distance of five inches from the woven cloth and requires pushing

up into close contact with it. The motion of the sley combined with the reed performs this operations which is imparted to it by a crank, and which is connected to the sley by means of a crank arm. The crank gives a reciprocating movement to the sley. The sley moves upon a rocking shaft as a fulcrum, and when the crank is at the front centre the sley swords should be perpendicular or nearly so. The movement of the sley should be eccentric because this action will allow the active movement at the back extremity of the cranks revolution to be as slow and protected as possible in order to give the travelling shuttle all the advantages of a fully open shed. At the front extremity, the movement should lose as little of its momentum and give as short a pause as possible, so as to drive up the weft sharply and firmly.

Dwell of the Sley.

The eccentricity of the sley's movement depends upon the length of the crank and crank arm, and upon the position of the crank in relation to the point of connection of the crank with the sley. The position of the crank shaft in relation to the connecting pin varies in different makes and widths of looms. Were the crank shaft at the same level as the sley sword pin, the dwell at each end of the stroke would be exactly equal. It is obvious that there must be a dwell at the most backward position of the sley, of some duration, however slight for the purpose of beating up the weft, a smart blow by the sley and reed is absolutely necessary at the most forward position. To obtain this, the duck bill and the heater must be set correctly. This is a most important factor which the jobbers are often found neglecting.

The centre of the crank shaft is at a lower level than that of the connection of the crank arm with the sley sword ears, and thus the sley dwells longer at the healds than at the cloth. The wider the loom is the smarter the beat-up is required, and the longer crank is necessary to be in order to allow time for the shuttle to pass.

The longer the crank, the greater the velocity of the sley, therefore a long crank arm is suitable for heavy work, because it stores up more forces in the sley than a short one. The force may also be increased by shortening the crank arm, thus increasing the eccentricity of the sley. If the connecting arms are allowed to work slack, the movement of the sley will be a jerky character causing vibration in the loom, excessive wear and tear on the bushes and the crank, and thick and thin places in the cloth, which is due to irregular beating-up of the weft and letting-off of the warp.

To remedy this fault the cotter must be driven further into the slot, because this tightens the crank straps which hold parts of the crank arm together. In case of too much of slackness of crank arm, a strip of leather is placed between the cotter and the jib.

The beating-up motion, which is brought about by the forward move of the sley, seldom requires any adjustment. The sley swords should be vertical or nearly so, when the reed is at the fell of the cloth. With the swords in this position the force exerted by the reed at the beat up will be approximately along the line of the cloth and a cutting action will not be brought to bear on the weft. Any adjustments which are necessary in this connection are effected by moving the rocking rail brackets in the appropriate direction along the slots in the ides of the loom. Care should also be taken that the sley is level at the correct height. The height of the sley can be adjusted at the bottom of each sley sword where the latter is connected to the rocking rail.

Object of Take-up Motion.

The positive take-up motion is generally employed on cotton looms owing to the regularity of speed, this motion is well adapted for looms weaving cloths composed of yarns of a regular uniform character. The take-up motion is the auxiliary motion of the power loom, and without which a power loom would be of little practical use, though it may be considered as an adjunct to the three motions already mentioned and as a part of a whole with regard to the operations done by them.

The object of the take-up motion is to wind the cloth on a roller as it is woven, and by regulating the speed at which it so winds the cloth determining the closeness of the weft threads, as the warp threads are determined by the closeness or fineness of the reed.

The operation is performed by means of a train of wheels, every time a pick has been inserted, and to coil it round the sand roller in a manner which will prevent it from being soiled.

Taking-up Motion.

In the ordinary taking-up motion the rack wheel of 50 teeth is moved forward one tooth every pick by a taking-up catch which is worked by taking-up lever, that is, connected to one of the sley swords, the letting-back catch prevents it from going back. On the same stud is the change wheel, this gears with the carrier wheel of

120 teeth firmly connected with the pinion of 15 teeth, driving the beam wheel of 75 teeth. The beam or sand roller is 15 inches in circumference, and is covered with perforated brass sheet which holds the cloth firmly. The taking-up catch is the weak point; it may slip over a tooth, take two teeth, or may not be strong enough to take them regularly, hence irregularities are frequent. The heavy weighting necessary for certain goods often prevents the taking-up catch from acting correctly.

The cloth, as it is woven, is drawn forward by the sand roller and is wound upon the cloth roller, which is pressed against the sand roller by weighted levers and is turned by friction.

The change wheel is varied to give changes of picks in the cloth, a large wheel giving fewer picks in the quarter inch, as it is a driver, therefore, the greater the number of teeth it contains the greater will be the speed of the cloth roller and the less will be the number of picks to the inch in the cloth woven. A small number of teeth will give a cloth with a large number of picks to the quarter inch.

Each gear has a constant number associated with it, called a dividend. If the number of teeth in a change be divided into this dividend, it gives the picks in a quarter inch of cloth. Imagining that a change wheel, having the effect of only one tooth in revolution, could be applied, then the dividend is the number of picks that the loom would run before the sand roller advanced a quarter of an inch. Suppose 508 dividend is taken, this represents a change wheel supposed to have one tooth. If a wheel of 60 teeth be put on, only 1.60 as many picks to the quarter will be inserted, *i.e.*, $508 \div 60 = 8.46$ picks. The method of obtaining the dividend for any ordinary gear is :—

Rack wheel. Carrier wheel. Beam wheel.

$$\frac{50 \times 120 \times 75}{15 \qquad 60} = 500$$

Pinion wheel × Circumference of sand roller in $\frac{1}{4}$ inch.

Add $1\frac{1}{2}\%$ for shrinkage after being released from the tension of the loom.

$$\times 8$$

508 Dividend.

It will be seen that the quotient in every case will not be a whole number, and a change wheel must be employed which has a number

of teeth slightly over or under, with the result that it is not always possible to get the exact number of picks to the inch in the cloth.

In a train of five wheel take-up motion, the fabric is drawn forward as the sley falls back, and the pushing catch acts when a shed is quite open, and the strain greatest on the warp threads; but in a train of seven wheels, a pulling catch operates when the sley moves forward, thus acting on the sound principles of drawing the cloth forward at the time when the tension upon the yarn is being diminished owing to the shed being decreased, resulting in less breakages in the warp yarn. For the same reason a pulling catch consumes less power in drawing the fabric forward than a pushing catch, and it is less liable to slip. Also an alteration of one tooth in the change wheel (in the case of five wheels or positive take-up motion) will make too great a change in the fabric, hence a variation from the above described motion is to use a train of seven wheels or pickles motion.

Pickles Take-up Motion.

In Pickles motion the change wheel is a driven wheel, and it will be obvious that, as the teeth increase, the speed of the train will decrease in direct ratio, and allow a corresponding increase in the picks per inch, so that if the wheels are so proportioned that the change wheel has the same number of teeth that they are picks per one inch, it will always remain so whatever size the wheel is. If a 10-driver wheel gives 10 picks a 40 will give 40 picks and so on. A wheel which is called a standard wheel is also changed. This is driver wheel, and therefore a smaller wheel gives more picks, and *vice versa.* The wheels are so proportioned that if the standard wheel has nine teeth, each tooth in the change wheel represents one pick, and therefore this wheel being a driven, the number of teeth in it will also represent the number of picks per inch. If an 18-standard wheel is used it is obvious that the sand roller will be driven twice as fast, therefore each tooth in the change wheel will then represent half a pick per quarter inch. With a 27-standard wheel each tooth in the change wheel will represent one third of a pick. With a 36-standard wheel each tooth will represent a quarter of a pick per inch.

Standard wheel.	Picks per $\frac{1}{4}$ inch per Tooth of change wheel.
36	1
27	$1\frac{1}{3}$
18	2
9	4

Q.—Having 36 teeth, standard wheel on loom in which a cloth with 18 picks to the quarter inch is required to be woven, and a change wheel of 72 teeth is not available in the place. What would you do to get 72 picks to the inch ?

A.—I would change the standard wheel (36 teeth) to 27 teeth and put a 39-change wheel ($13 \times 3 = 39$) to get 13 picks in the quarter inch.

The following wheels are mostly used for Pickle's motion :—

Rack wheel	=	24 teeth.
Change wheel or standard whee or rack wheel stud	=	36
Change wheel	=	40 (if 40 picks per inch are required).
Swing pinion wheel	=	24
Carrier wheel	=	89
Carrier wheel pinion	=	15
Beam wheel	=	90
Circumference of roller in $\frac{1}{4}$ inch.	=	60

Cracks and Thick Places.

To weave heavy pick cloth with ordinary positive take-up motion, the rack wheel might be increased to 60 from 50, and the dividend would, then, be 634 whereas in the case of Pickle's motion both heavy and light pick cloth can be woven without a very great variation in the wheels. It may be of interest to mention (of course depending to a certain extent on the class of cloth being woven) that, in actual practice, the theory does not exactly agree; for instance, a 70-pick cloth sateen may only require a 68-change wheel instead of a 70, when a standard wheel of 36 teeth is used, The cloth may be drawn forward when weft is absent, and unless a weaver lets back the fabric before recommencing to weave, cracks will be produced. Cracks and thick places can be avoided by weaver's skill to judge correctly the distance to reverse a cloth after unweaving, and after weft has been broken.

To set the ordinary positive taking-up motion, the taking-up lever catch must be set to push forward one tooth on the rack wheel when the crank is at the front centre. When the crank is at the back centre, set the letting-back catch to clear a tooth by about $\frac{1}{8}$ inch and set the monkey tail that works the taking-up lever, so that it will take one tooth at a time, and for the regulating finger which is in conjunction with the letting-back catch, set it so that it

will allow the letting-back catch to rest on the bottom of the tooth on the rack wheel, whereas in the case of Pickle's motion, the taking-up lever catch must be set to push forward one tooth on the rack wheel when the crank is at the back centre. When the crank is at the front centre, set the letting-back catch to clear a tooth by about $\frac{1}{8}$ inch. An important point is to set all the wheels in connection with the taking-up motions right, because if they are set too deep in gear they will bind and cause the taking-up catch to miss, and taking-up sometimes, and at other times, to take up two teeth instead of one. Another evil, is, if the wheels bind it will cause the teeth to break out of them. If they are not set deep enough in gear they will slip backward and forward instead of taking-up. These things show us that they require great care and attention in setting taking-up motion, and to work rightly, all its parts must work free and easy, and to keep them so, it is absolutely necessary to keep them well cleaned and oiled. When cloths are lightly picked and change wheels with the proper number of teeth are not at hand, the taking-up lever catch is made to take two teeth at a time by raising the position of the monkey tail to the top of the slot in the taking up lever, and reducing the teeth in the change wheel by one half.

Let-Off Motion.

Uniform tension should be maintained in the warp as may be required for various counts. The resistance applied to the ruffles ought to be gradually decreased to correspond with or neutralise the increasing tension which the warp line, from the beam of the back rest, imposes on the yarn as the empty barrel is approached. Care should be taken to see that the weighting is evenly balanced and the weights are never allowed to touch the floor. In the event of beam lever weights occasionally touching the floor, the warp is then allowed to slip a trifle, owing to the part of resistance to turning of the beam being momentarily removed. Thus the insufficient tension of the warp causes a prominent thin place to appear in the cloth. The trouble can easily be rectified by lifting the weight lever with one hand, and with the other hand moving the cotter in the vertical regulator hook one hole higher. The chains which surround the ruffles of the beam should be kept clean and in order, from time to time, so that the motion may be sensitive and respond readily to any variation in the tension of the warp. The chains and ruffles should be oiled before the commencement of a new warp. By increasing the number of coils in the ruffles, or by adjusting the position of the weight on the lever, or by means of additional weights (such as,

compound weight lever), the tension may be varied. If the chain is coiled too frequently round the ruffles and excessive weight placed on the levers, the delivery of the warp will be very irregular due to the chains maintaining their grip on the ruffles, without allowing the warp beam to slip forward. In the endeavour to produce the even cloth, the coiling of the chain round the collar is most important, and must not be overlooked. This is also a detail which influences the number of weights, or their position on the levers. It is of utmost importance that a great amount of attention must be demanded from the weavers to regularly adjust the weight as required for the decreasing diameter of the warp on the beam from start to finish of the warp. Should one or both ends of the back rest or back bearer have dropped slightly but sufficiently far to make contact with the beam flanges, it will naturally prevent the beam revolving evenly, as this will be held back for an excessive number of picks, and then suddenly caused to slip, resulting in a thick and thin place being developed, which can occur either when the loom is running ordinarily or when being re-started. If the pair of lease rods be too near the healds, or only the front rod too near the healds, or when the rods are widely set, the short length of yarn extending from the back lease rod to the healds will form a greater angle, which will result in a jerky let-off.

The Tension of the Warp.

Although it might appear that the taking-up motion draws off the warp from the beam, yet this is not absolutely the case, for the warp is nearly drawn off by shedding and the stroke of the sley.

The warp should be worked nearly as tight as the strength of the yarn will permit, because the appearance of the cloth depends a great deal upon tension. The cloth will present a raw lean appearance, if it is woven too slack: whereas if the warp is held too tight, it will cause considerable breakage of the yarn, giving the cloth a hard, harsh appearance and feeling.

It is absolutely necessary that the beam on which the warp is wound, the back bearer, the cloth and sand roller, the breast beam etc. must be perfectly parallel to one another.

The Weft Stop Motion.

The object of the weft stop motion is to stop the loom on the breakages of the weft, or when the cop or bobbin is finished. It is placed between the edge of the cloth and the shuttle box at the

driving side of the loom, The grid is let into the back board and placed at the side of the reed vertically with its spaces facing the prongs, between the reed and the shuttle box.

The Weft Fork.

The fork is so placed that, as the grate moves forward, the prongs of the fork pass through the grate—¼ of an inch is ample for the prongs to project through the grate. When the weft comes between the fork and the grid, it raises the end of the fork out of the way of the hammer which is moved forward every two picks by a tumbler boss on the tappet shaft of the loom. The prongs of the fork will pass through the grate, unless the weft is laid between them, when the sley moves forward to beat up the weft. The presence of the weft enables the grid to push it against the prongs with sufficient force to raise the hooked end of the weft fork and the loom will continue to run. If the weft breaks or runs out, the fork will, of course, pass through the grid, and it is so that the hooked end of the fork will be caught by the hammer and the loom handle knocked off. The weft fork which is free to swing upon a pin is supported by means of a holder which is in turn set screwed to the weft lever that occupies a horizontal position immediately behind a starting handle. Therefore any backward movement of the grey hound tail, when the hooked end of the fork is resting upon the top of weft hammer, will cause the weft fork lever to move outward, so as to cause the friction brake to drop into contact with the brake pulley, throw the take-up motion out of action, the starting handle off its notch, and throw the belt on the loose pulley. The bent arm of the strap fork lever is passed through the starting handle for this purpose.

When the loom is on the top centre, the distance between the hook of the weft fork and the sneek of the hammer should not exceed ¼ inch under ordinary conditions, else the capacity of the two parts acting in conjunction will be reduced in the actuation of the weft lever and the slipping of the starting handle out of position whenever the weft fails or breaks.

The Tumbler Boss.

If the tumbler boss is not made to act upon the grey hound tail by means of a neb which is attached to the tumbler boss, at the moment that the reed is beating up the weft, the loom will be continually stopped, because at this point the hooked end of the fork is raised to its highest point by the pressure of the weft on the prong. The tumbler boss is set relative to the hound tail, so as to be about ¾ inch from commencing to raise the latter when the crank shaft is occupying the full front centre, with the shuttle ready to be picked

from the starting side of the loom. It is sometimes desirable to adjust the tumbler boss a trifle late when using fine counts of the weft in order to minimise the possibility of the fork catching the hammer, owing to the fork not being sufficiently raised. It is requisite that the fork should work with freedom in the holder, and that the prongs of the fork must not touch the side of the grate or race board, nor yet be in contact with the sley, otherwise, the loom will continue to run after the weft has given out or broken, because the contact between the two will have the same effect as if the weft was pressed. The fork's prongs must be low enough to prevent the weft passing beneath them when the fork is set too far away from the grid, the weft will not exert enough pressure to raise the hooked end clear of the hammer.

Light weft fork should be used for fine yarns so that too great a pressure will not be put on the weft. The weft when it runs off easily must be tensioned by means of a piece of flannel placed near the porcelain eye of the shuttle, or there will not be sufficient resistance to make the fork act, and the loom will be continually stopping.

The Brake.

An effective brake in a loom is an essential adjunct to the driving motion, its function being to prevent the loom from overrunning when thrown off—that is, when the weft supply fails. There are various types of such motion, each being constructed according to the requirements of the loom to which it is applied. It also contributes greatly to the manufacture of even cloth. Should the stopping arrangements be ineffective, thin places and cracks will be numerous, because, when the loom is stopped in the usual way by the weaver the brake remains inoperative.

Usually the brake is a simple lever, which has an adjustable weight hung upon one arm. The other arm, called the brake bit or clog, is curved on the inside with leather for the purpose of increasing its holding power. The brake bit is placed immediately below the brake wheel, and so governed that both may be instantly brought into contact when a weft breaks, or when a loom is stopped by other means. The weighted end of the brake lever is connected by a connecting wire which connects the brake lever and brake lifter that rests upon a bonnet which is affixed to a starting handle. When a loom is put in motion the brake lifter is raised by the pressure of bonnet against its full side, and the connecting wire

lifts the heavy end of the brake lever sufficiently to move the brake bit out of contact with the brake wheel. If the weft fork acts the brake lifter falls, the brake lever bears upon the brake wheel and brings a loom to a stand. A hook or connecting wire for brake lever on the top of the brake lifter renders this brake inoperative, except when the weft fork lever is drawn forward.

To work the brake right it should be made to stop with the shuttle at the fork side, and it is supposed to lose about two picks. When it does so, consequently when the shuttle is changed, the regulating finger, which lifts the letting back catch by means of folding back catch rod, should be held while the loom runs two picks so that there will be no irregularity in the cloth; therefore, to make stop as required, regulate the brake by the lever and weight and do not allow the driving belt to run on the fast pulley when the loom is stopped.

It is the best idea to make the loom stop when the crank is a little over the back centre, so that it gives the loom a proper chance to start. It will, by this means, both prevent cracks in the cloth and the loom from banging, and in loose reed prevent a smash.

Balance Wheel.

A balance fly wheel or hand wheel is usually fixed on to the end of the crank shaft as an appendage to the driving motion; enables the weaver or jobber to manipulate the loom by hand when necessary. A minor advantage in the form of kinetic energy is also derived from the wheel, which assists, although in a small degree, to overcome the variable resistance encountered by the driving motion in turning the crank shaft one revolution. If the weight of this wheel and the consequent amount of accumulative work were too excessive, more effective breaking power would be required.

Temples.

Temple rollers are employed to counteract the pull by the weft in order to contract with the fabric in the direction of its weft during the operation of weaving. They also prevent the edge threads from being broken by the reed, and the reed being injured by the warp.

Failing the use of these (temple rollers), the warp threads would be much closer together at the sides than in the middle portion of the fabric. Cloth contracts in widths by reason of the tension upon both warp and weft. Light medium and moderately heavy fabrics

are woven with side temples. These are all rollers acting only for a distance of 3 to 4 inches at the selvedges of the cloth, single, two roller, or three roller temples are adopted to hold out light medium or heavy fabrics respectively. One pair is usually used at each side. These are fitted in a cast iron case and mounted at each side of a fabric upon a rod of iron. Finely pointed steel pins are driven into the rollers spirally. The body of each roller then contains a larger number of short, sharp points which lean towards the edges of the cloth. Broad looms are chiefly provided with inclined ring temples which are excellent for holding out and stretching a fabric, especially between the reed and the bite of the ring. A temple roller case is opened below to allow size and dirt to fall out. A movable cap screwed down tight, while setting the temples, makes them stand as near the reed as possible without touching it, when the crank is at front centre. Do not let them stand more than a quarter of an inch lower on the front side nearest the reed than the back side, and set them as near the sley bottom as possible without touching it when the loom is working.

How to Determine the hand of a Temple Roller.

The hand of a roller is determined by holding the roller, with the pins pointing outwards, and rotating it in the direction it should revolve when the cloth is rotating it in the loom. Note also the screw or set of the pins, for they should always be screwing towards the outside or selvedge. Thus, when tested this way, it will be noted that a left-hand roller, rotated as it turns in the loom, screws towards the left-hand side, while a right-hand roller screws towards the right-hand side.

Timing.

The influencing factors of great importance in timing and setting of the picking motion are the width of the looms, and the classes of the cloth to be woven. Since a crank shaft receives the motive-power direct, and transmits it to other parts of the loom, all movements are regulated by this shaft. When the crank is at the front centre, in weaving a plain cloth, the reed touches the cloth at right angles or beating-up takes place. The healds are then slightly opened, forming a new shed which must be a good clear shed of correct depth and height to suit the shuttle. Neither the sheds should press on the race board too heavily nor yet too far from the race board. As the sley moves backwards just in front of the bottom

centre, the picking band is tight and just commencing to move the shuttle. The use of two odd shuttles at the same loom should be always avoided. Both the shuttles should be identical in depth, width, level and weight, and correctness in convexity of reed and concavity of race board. The level of reed to race board must be correct, which level must be identical with level of the shuttle, the level of the back board must also be equal to the level of the shuttles. The reed should not overface the back board, and these should be in perfect alignment. The sley plate should not be lower than the race board. The reed must securely be held in position in the sley and the sley cap. The length of a picking band is obtained by turning the cranks on their back centres, and moving the picking stick backward and forward, the picker should then slide freely from end to end of its spindle without the picking band being unduly slack.

How to Set a Spindle.

The spindle should be at the correct height and at a greater distance from back board at the stud than at the other end. The end of the spindle secured by the stud must be from 1/16 to $\frac{1}{8}$ of an inch higher than the opposite end, measuring in both cases from the bottom of the shuttle box, also about $\frac{1}{8}$ of an inch further apart from the back board at the stud than at the box end. This slight inclination of the spindle from stud to box end is necessitated by the pull of the picker always happening on the underside of the spindle when picking takes place. The necessity of the stud end of the spindle occupying a higher position than the opposite end is to counteract the tendency of the shuttle, rising in its delivery to the race board. The length of the spindle directly influences the picking motion. The lengths of the spindles for various widths of looms are given below :—

Width of loom.				Length of spindles.
From	28	To	54	18″ × $\frac{3}{8}$″ Dia.
	58		72	18$\frac{1}{2}$″ × ,, ,,
	80			20$\frac{1}{4}$″ × ,, ,,
	100			22″ × ,, ,,

If, however, it is necessary to lengthen or shorten the picking band this can be done by adjusting the picking band itself or by loosening the nut that tightens the picking stick on the picking shaft, and moving the picking stick in or out, in either case the time of picking will be altered. The picking shaft should be absolutely vertical;

there should be no binding in the top bearing nor in the foot step; the picking power should not be excessive nor the pick too harsh and jerky. The picking cone in the vertical slot of the picking shaft should not be lower than is absolutely necessary, lest a jerky and harsh pick will be the result but the lightest and smoothest possible pick should be employed.

At the point when the shuttle is commencing to move the healds are full open and remain so until the crank passed the back centre when, as the shuttle has arrived in the opposite box, the shed begins to close. The healds are level before the sley has reached the front again. The tumbler lifts the grey hound tail for the weft stop motion at the moment that the reed touches the cloth when the fork will be lifted if there were weft in the loom. This only happens every alternate pick, when the shuttle is at the fork side of the sley. The monkey tail on the sley sword moves the take-up catch as the sley moves back, just dropping the holding catch as the crank reaches the back centre. The driving wheels and the taking-up motion must be properly geared, neither too shallow nor too deeply. The reed is held tightly in a loose reed loom when the sley approaches the front provided the stop rod blade is set properly.

Early and Late Picking.

It is advantageous, when weaving with tender weft or badly spun weft cops, to time the picking a little earlier. This gives the shuttle more time to travel across the race, and the pick need not be as strong, so that a gentler action is applied to the weft as it is drawing off the cop. Late picking is sometimes adopted to allow the boxes a little more time to arrive at a state of rest before picking takes place. Usually late picking is resorted to in order to increase the force of the pick. This is a bad practice, since late picking is always harsher the nearer the crank is to the back centre when the actual blow is delivered. This is attended by considerable friction, especially in the driving wheels, in which, if the teeth are not broken, they quickly wear out.

If the cloth being woven is as wide as the loom will possibly admit of, or if the shuttle boxes be short, then picking must necessarily take place later, as the shuttle starts so close to the cloth, consequently shedding must be later or the shed will close before the shuttle is through. The pick in this must be stronger as the shuttle has more friction in its traverse.

In weaving light goods, a weak and rather early pick is required, but for heavy goods, a later or stronger pick is wanted. The late pick must commence to operate previous to the crank arriving at the bottom centre, otherwise sufficient time will not be allowed for the shuttle to pass through the shed, which will cause the shuttle to lift. The early pick on the other hand must not occur before there is a shed to receive the shuttle, else trouble will inevitably follow.

To time a pick, a picker is held against a box end, and the crank shaft is turned until the picker begins to move, that is, until a picking stick has moved inwards sufficiently to tighten the picking band with the picker ready to move the shuttle. If the crank do not occupy their proper position (that is, when the cranks are between their back and bottom centres), the bolts that pass through the picking boss and plates slots are loosened, the picking plate and the neb moved in the required direction, and screwed tight. A large shuttle will hold a greater length of weft but it should not be too large, or their increased bulk will necessiate a deeper shed. More time is needed to repair warp than to replace weft.

Picking motion must, of necessity, be timed and set to work in harmony with the shedding tappets. The picking stick must be in the correct position. The brake must act properly to ensure the loom being stopped with the shuttle at starting side and the crank at back centre; when the crank has only made two revolutions after the action of the weft fork. The weavers will thereby save much time when changing the shuttles. All spring must be kept in good condition and set not to exercise any excessive power. All parts which assist to check the shuttle should be worked properly. Reduce banging off, flying shuttles, yarn smashes, uneven and reedy cloth, and slovenly selvedges, cut weft, grease, snarling weft, oil stains to a minimum.

Care of Healds.

Few faults impose a greater handicap on the weaver than do broken healds. Not only is time lost through stoppages to piece the healds, but the broken healds may cause smashes by getting entangled in the shed, or may produce floats, or may even cause shuttles to fly out.

The jobber must be careful when attaching the heald cords, to make sure that none of the healds are crossed or pulling. If eyelets or hooks are used to connect the cords, he must take care that the

connections do not fridge the healds; if the cords are threaded through the shafts, he must see that they are quite straight. The connecting cords must pull perfectly straight in order that the healds will lift quite perpendicularly, otherwise chaving will result.

Any undue strain on the healds causes bad weaving, because the heald eyes tend to close under the extra strain each time the heald comes to the faulty position; the closing heald eyes will nip the warp ends and cause bad weaving by reason of the ends breaking in the eyes.

Care of Reeds.

It is no uncommon thing to have a reed damaged while in the loom, such damage being reflected in the appearance of the cloth. The cloth woven with a strained reed looks as if it had been woven with ends out, and appears very reedy. A reed may become damaged in many ways, as through the weaver catching the shuttle tip in the dents of the reed when inserting the shuttle in the shed, or through such accidents as a piece of leather or other hard substance coming in contact with the reed during the beating up. Damage may also be caused through knocking the sley cap down too hard on the reed, or, occassionally, through a nail—head standing a little too high in the bottom reed groove of the sley or through a piece of metal getting under the dents and pushing a few of them up out of position.

Generally a strained reed is easily repaired by the use of a knife blade to straighten the wires in the baulk, the reed bottom being pushed out of the reed casing, or the sley cap removed.

Tha Life of a Belt.

When a loom belt is too slack, too dry or requires piecing up, the jobber should attend to it at once. Belts are expensive when they do not receive regular attention for maintaining them in the best of conditions at all times, if slip is to be cut down to a minimum. Besides, in weaving, small quantities of fluff and fly are constantly being created and thrown into the air. The belt should never be cleaned with a piece of card clothing, as this affects the smooth surface of the belt, and thus kills to a certain extent the grip upon the face of the loom pulley. Belts while running may be cleaned by the use of a fairly stiff bristled brush, or hard waste. In cases where the belts are very dirty the volatile solvent may be allowed to assist the brushing—Paraffin and petrol are suitable cleaning agents.

Leather belts must be well protected against water and even moisture. In order to prevent belts from becoming hard and cracking, it will be found efficacious if an occasional treatment of castor oil mixed in equal proportion with tallow at the back of the leather is given; a careful attention will make a belt last five years, which, if neglected, might not last one. Before applying the dressing the belt should be thoroughly cleaned with wet cloth, a good belt will add to the picks per minute of the loom. In fact if the belt drive is of the best type, with good belt contact, properly maintained tension and cleanliness, the probable increase in production would be from 4 to 5 per cent.

Resin should never be used as it tends to destroy the belt and nor does it any good, though it is very commonly used in every department of the mills. Belts should not be allowed to be actually broken, but repaired or laced during the spare time. The point of the belt must be equally pliable, and not bulkier than the rest of the belt. The hair side of a belt put next to the pulley will drive about 30 per cent. more than the flesh side. Never add to the work of the belt so as to overload it. The piecing-up of the leather belts by lace is far better than using metal strap fasteners.

A riding belt should not be allowed. When the driving motion consists of a loose and fast pulley, it is not usual to have the full width of the belt on to the fast pulley when the loom is running, but to allow a portion to remain on the loose pulley. There are two reasons for this; first, it affords means for adjusting the belt to the fast pulley in such a proportion as is required to drive the loom effectively; and second, the traverse of the belt being fixed at the minimum, it runs off the fast pulley much quicker when the loom is stopped.

A number of slack belts here and there will also be a bad drawback to production. If the belt were to stretch as much as two inches, contact on the pulley would be lost. A belt should never be made too tight; it should rather be allowed to sag slightly. The life of a belt or the length of time it will run is always a matter of considerable importance, and will depend, to a great extent, on the manner in which it is kept.

The Joint of a Belt.

As the strength of a chain is the strength of the weakest part or the weakest link, so also the strength of the belt is the strength of the weakest part or the joint. It is impossible to make a joint equally strong as the rest of the belt unless best laces are used in

splicing up the ends. It is very important that the lace should be small in size and very strong, not wide, and too thick to settle in the holes and be level with the surface of the belt. It is only the laces, during work that are stretched, being in immediate contact with the pulleys, and the results are frequent breakages of belts accompanied with the stoppage of machines. Laces to be good should not be thick raw hide, and should never be used in a fresh condition, for when new, they contain moisture and are more or less pulpy. They should be dried for six weeks or more in a place where there is a constant current of moderately warm air, then steeped in good oil ($\frac{2}{3}$ castor oil, $\frac{1}{3}$ neatsfoot oil) for at least two months, and afterwards hung up and gradually dried from six to eight weeks. Laces do not strengthen but weaken the belt. The lace hole should be punched in a diamond shape row and not in a line across the belt, as this weakens the belt considerably. An oval punch must be used, or still better a hole should be made with a mochi's (cobler's) broad pointed needle; the longer diameter of the punch being parallel with the belt so as to cut as little of the effective section of the leather as possible. Again, the holes should not be too close together, and should be made smaller in size than the thickness of the lace employed. The lace should be drawn tight through the holes. The holes should be made $\frac{3}{8}''$ from the edge of the belt. The two ends of a strap should be thinned down and see that the overlapping is not too great and that it is made correctly, so that the end placed over the hair side of the belt point in the same direction as the pull of the strap. Begin to lace in the centre of the belt and take much care to keep ends exactly in line, and to lace both sides with equal tightness. The lacing should not be crossed on the side of the belt that runs next to the pulley. The loom should be started with the crank on either the back or top centre and assist the sley forward with one hand to prevent a crack in the cloth on re-starting the loom. A loom will not generally start up properly with the crank on the front centre.

Weights at the Back of a Loom.

The Weights at the back of the loom must be carefully attended to and re-adjusted often, as the yarn is exhausted or withdrawn from the weaver's beam, especially when nearing the end of the warp. Both the weight levers should have equal weights, otherwise cracks, thick and thin places will be the result. If too much weight is put on when it is not necessary, then the peace of the cloth will be narrower in width and longer in length to a certain extent.

The fault is not always that of the jobber, who may have set the weights correctly, but is often due to the weavers tampering with the weights afterwards and thus changing the tension.

Loom Faults.

Cracks.—These may be due to the reed casing not being too rigid enough at the time of beating-up, reed insecurely held between the sley and reed-cap groove, excessive looseness of cranks, crank-shaft brackets and rocking—rail footsteps, bad shedding through tappets slipping on bottom shaft, top roller working stiffly.

Cracks and thin starting places are caused by careless weaving and careless line jobbers, and it requires so little skill to keep brakes in order (constant attention being, of course, necessary) that it becomes difficult to understand why line jobbers are so careless in this respect. Every time a new beam is gaited, the brake motion should be examined, reset if necessary, new friction leather applied if required, and the weaver warned that the motion should not be tampered with, and also that he must inform the line jobber if it is not acting correctly. The weaver should not to have to 'let back', an operation which takes time and hence causes a loss in efficiency.

Thin Places.

The take-up motion accounts for many of these such as, incorrect timing of catch, clearance of catch from one tooth to another, gearing clogged or too loosely meshed, worn catch or pawl, wheels binding on the studs, worn ratchet wheel, weaver moving by hand the whole motion a few teeth, gearing insufficiently let back by hand after a weft break, the finger near the starting handle not being held long enough when starting after the weft was broken. Other places, to look for are, ruffles or collars on beam loose or incorrectly fitted, gudgeons or pikes bent, weights occassionally touching the floor worn chains or ropes, uneven weighting of beam, ropes or chains sticking due to dirt or damp conditions, not adjusting the weights as the yarn on the beam reduces, incorrect timing of weft fork, worn brakes allowing the loom to run on a few picks before stopping, emery roller not gripping the cloth properly, crank pin worn.

Thick Places.

Thick places in all cloths are made by crowding or cramming more picks of weft in a small place than in the body of the cloth, and often are caused by the weaver 'letting back' a few picks before restarting the loom when replacing weft.

The take-up motion may cause some of these such as, gearing clogged, worn pawl and finger rod, gearing binding on stud, catch set with too little clearance, worn ratchet wheel, sley sword bracket finger near starting held too long or set too close to weft fork holder lever, worn beam pikes, ruffles on beam having a flat place or wrongly fitted, weights touching the floor occassionally, flange binding on back rest or the frame cross stay, uneven weighting, chains or ropes sticking, weft fork badly timed, emery roller not gripping the cloth properly, uneven beat-up through crank pins being worn, reed case insufficiently rigid when beating-up, brake not in order.

Shuttle Traps.

Entanglement in shed by ends breaking or other things flying in shed, small shed, shuttle rebounding, shuttle loose in box, damaged shuttle, stop-rod motion not acting, wrong picking.

Wrong Number of Picks.

Yarn coming off beam too slackly, take-up motion out of order or wheels or studs worn, beating-up in-correctly, weaver turning the take-up motion, emery or cloth roller worn.

Broken Picks.—Tension on weft too strong or irregular, soft weft, thin and thick places in weft, weft being cut at some place in or near the box.

Cut Weft.

Rough shuttle tongue, loose shuttle tongue, eye of shuttle cracked or rough, peg too high or low, shuttle box front rough, weft fork not going through the grate properly, broken or jaggy buffer, faulty weft received from spinning, temple set too near the reed, groove in shuttle not being the same height as groove in box front, worn or nicked shuttle.

Bad Selvedges.

Tension on weft too great, temples not holding the cloth, too few selvedge ends, bad winding on or near flanges of weaver's beam, loose flanges, shuttle rebounding, unequal shedding, narrow cloth in broad looms, snarly weft.

Reedy Cloth.

Line of warp from back rest to breast beam out of correct line, back rest too low, lease rods too near the healds, too large shed, wrong dwell, warp too tight.

The line jobber must always remember that the setting of the back rest is of the greatest importance, if reedyness is to be avoided and a full well covered cloth woven. The standard position is for the front and back rest to give a straight line to the sheet of warp, and such a setting is likely to give a reedy cloth, for the same or equal tension is exerted on both the top and bottom sheds. But if the back rest is raised a little, then there will be more tension on the threads forming the bottom line of warp, hence when weaving, of every pair of threads, one will be tight and one slack, and the tight one will force itself into the middle of the space between the slack threads on either side of it, thus giving a cloth in which all the threads are equi–distant, or evenly spread out. Of course, there is a limit to the height the back rest may be raised, because too much tension on the bottom shed may give bad weaving, or a bottom shed not just lying on the race–board, thus tending to cause shuttle flying. Again, if a top shed is too slack it will wear the shuttle and may cause stitching. Some line jobbers try to get cover by lowering the sley, but this should not be done, as it affects the running of the loom. Possibly the duck bills will not clear the heater spring if the shuttle is caught in the shed. Soon shedding helps to give cover, for it means that the beat–up takes place on a crossed shed. Now in such a case the tight or top line of warp is under the last pick put in, that is the tight warp, and this will tend to bend or distort the pick of weft, forcing the slack ends of warp between the tight ones, giving the same result as above in a different way, a well covered cloth.

Picking Over.

Worn shuttle, top shed too low, shedding early, late picking, slack picking band.

Temple Marks.

Roller clogged, wornpoints, rings sticking.

Snarled Weft

Shuttle eye too large, checking of shuttle in box, late picking, strong picking, bad tension on exit of weft from shuttle, uneven places in weft, weft hard twisted, snarls in bobbins or cops.

Faults Due to Imperfect Weaving.

(1) Bad manipulation of the warp in the loom. (2) Unnecessary strain placed on the warp (3) The working parts of the loom not set correctly. (4) Careless weaving (5) Breakage of pickers, picking bands, shuttles, heald cords, healds, etc. (6) Bare or reedy, giving

a badly 'covered' cloth. (7) Cracks and thick places (8) Stitching and picking over at the edges of the cloth. (9) Uneven cloth (10) Bad selvedges (11) Ends woven out.

Qualifications and Duties of a Jobber.

The jobber should be a good weaver and ought to be reasonably equipped with mechanical ability. He must be a smart, enthusiastic and tactful man, with good insight and foresight. He must use great discrimination in selecting his work people, and employ the best there are.

It is his duty to examine daily the tally boards of each and every one of his weavers, and see that he has produced the correct length or the average amount of cloth. If the weaver did not produce the right length, he should at once go to the loom and see that it is in a good running order, or the weaver is at fault.

If the weaver is at fault, then he must be warned and if still after that he continues not to give the right length, he must be removed and replaced by a better one.

But if he attends to the following details, as he has only to attend to 42 looms, there would be no need for a weaver to under-produce, unless he is not fit to be a weaver, and such weavers should not be allowed in his section: (1) The nuts and bolts on all brackets and other parts are thoroughly screwed up in their true positions to avoid unnecessary friction, and also thus avoiding the machinery from giving constant trouble during running, besides causing great wear and tear, loss of time and production. The more efficient the jobber is in the study of mechanics the more successful will be he as a jobber; (2) to replenish and gait up a loom with warp as soon as it comes out empty, and if he does not consider it a degradation when there are no coolies provided by the mill, he should help to carry the pieces from the looms of his section after they are drawn out from the cloth rollers to the booking table, so that the weavers will be more confined to their looms, and thus assist towards an increase of production ; (3) to see that the weavers under his charge are attentive to their work; (4) the loom oiled in the proper parts ; (5) to go round his set of looms and inspect the cloth on each loom several times a day for cover and finding out the following faults; (6) the taking-up catch is working correctly, either in the sense of

being under or over picked or irregular in picking; (7) the healds corded right to prevent chafing of the warp yarn; (8) the sheds are in order; (9) the heaters and duck bills are set correctly; (10) selvedges right, too many ends are not drawn in like a cord, particularly in the last two dents, which has a detrimental effect if the cloth is intended for calendering; (11) the warp beam not sticking occasionally owing to the chain not being oiled, etc.; (12) the pick is not too strong or too weak; (13) tappets not shedding too early or too late; (14) all cords, bands and belts which are showing signs of giving way should be renewed or attended to before they break; (15) increasing the power of the pick ought to be the jobber's last resort when seeking to remedy faults unless the nature of the faults demands that course; (16) he must give a little courtesy and consideration to those (weavers who have to handle badly sized or prepared warps; (17) he must be in the shed before regular starting time to look round to see that all the weavers are at their places and have the loom started in time; (18) He must take care to see that no yarn is thrown into waste, except what cannot be helped, and he must also make it his duty to collect the waste from each individual weaver separately, so that he can punish the weaver who produces more waste after assuring himself that the loom is not to be blamed. He must also see that no bobbins or cops are thrown about the place in his section to be kicked about by the passersby. This does not only make the place look as much untidy but the bobbins or cops are at times unnecessarily destroyed which means a great loss to the firm; (19) it is very important for a weaver's beam to be properly and well sized and it should contain clean, regular, round yarn, as far as possible with few knots and free from slubs, suarls, soft and thick ends, fluffy yarn etc. The breaking strength of the yarn should be at least up-to the standard. It is the duty of every jobber to insist on the weavers preserving such faults when they appear in great numbers, and he should show them to his immediate officer or head jobber. If proper attention is paid by the weaver, faulty cloths resulting from these faults can be minimised; (20) the jobber should see that the weavers are well provided with weft of the right count and sort. In case he finds the can of the weaver empty or about to get empty, he must at once proceed to the weft room and fetch a fresh lot for him, so that unnecessary delay is avoided; (21) when tender yarns are employed as either warp or weft, the loom should not be run at the same speed as for good elastic yarn. Because the time occupied by the weaver repairing the increased number of breakages would quickly counteract the advantages accruing from the high speed. To this should be added the increased cost of mending the pieces,

the waste of material, and the decrease in production. The head jobber who has commonly to attend to 400 looms should also after going through the average sheet of all the jobbers in his section, pick out the worst jobber, and try to find the cause of his average being down, and give him all the assistance he can if he needed it.

Hints to Line Jobbers.

(1) If a line jobber means to be successful—and to be successful means good efficiency, low damage, low waste and contented weavers —he must be sufficiently educated to detect any fault or trouble in a loom.

Jobber should keep a check on the amount of loom stores, such as, pickers, shuttles, picking sticks, check straps, springs, spindles, weft forks, shuttle tongues, oil, spare parts, etc.

(2) Any loom may be running in an unsatisfactory manner because one of its many parts is not working correctly, and it is the work and duty of a line jobber to be able to find which part of the loom is not correct, and also to be able to put it right.

(3) A loom is a long—suffering machine, and will continue to weave cloth—faulroy may be, but cloth—when quite a number of its motions are not working as correctly as they should. To detect these incorrect motions or parts is the work of the line jobber, and he will only be really capable and have sufficient ability to do his work, by careful study, keen and intelligent observation, and a good sense of touch.

(4) A good line jobber, by putting his hand on the sley while the loom is running, can tell how the shuttle is running through the two lines of warp, can tell also if the picks are too weak or too strong, and in fact, can tell if the loom needs "tuning." But he must be able to correct or remedy the defect when he has found out what it is.

(5) He must have a fair degree of mechanical ability, and some knowledge of carpentry. But first and foremost, he must be a good weaver or how otherwise can he tell, when a loom is producing faulty cloth, and if it is, whether the fault is due to faulty material to inefficiency on the part of the weaver, or to mechanical faults in the loom.

(6) The jobber should try to let his loom be stopped the least amount of time after his warp is woven out. He must ascertain for himself and not wait till the weaver will report to him when a beam will be woven out. There must always be a beam ready to go behind the loom before a beam comes out empty.

(7) It is a good idea, if the jobber will instruct his weavers to apply a little oil to the side of the shuttles when work is finished for the week end, so that the oil can soak in the wood during the stoppage and prevent as many splintered shuttles.

(8) Oiling to excess should be prohibited. If oil touches the face of the brake wheel, the loom will not be stopped with the crank shaft and the shuttle at the correct positions when the weft is exhausted or breaks. If the crank arm is oiled too much, it will throw it on the warp yarn on the beam, and thus a piece is rendered faulty. It is emphatically necessary to pay attention to keeping of machinery properly adjusted and oiled. The best machinery, if not given daily attention, will not only refuse to do good work but will go to pieces. Carelessness in a small degree may not only run the life of machinery but also result in serious accidents. The spindles should just be touched with waste dipped in oil and not too much oil poured on it, because it will drop on the sley plate and the shuttle will come in contact with it, and thus stain the warp yarn or the oil from the spindles may drop on the shuttle and stain the weft yarn. The picking bowl should not be oiled excessively as some of the oil will be thrown on the warp of the beam. It is wise to cover the beam by tying a piece of hessian cloth to the sides of the loom in such a way as to cover the warp from inside, and thus prevent it from being stained.

Hints to a Weaver.

The weights may be entirely removed when weaving last few yards of the final cut on the beam. When warp ends break, they should be pieced up without delay, and thereby prevent other warp ends being broken or entangled, and thus causing the shuttle fly out or the shuttle to become trapped, and break a number of ends. Before a cop or bobbin of weft is finished in the shuttle, the other shuttle should be threaded ready for replacing in the box when the loom stops.

It is a very bad practice on the part of the weaver to turn the carrier wheel (that is, to wind) a little forward by hand occasionally while the loom is running, because it is slightly bumping which can be remedied by more weighting the beam (of course not in every case but when necessary). But the weaver takes this as an excuse with the object of producing the piece quicker by causing less picks to be put in. The shuttle should be prevented from carrying grease or box dirt into the cloth by keeping the shuttle boxes clean.

Besides the toothed gearing wheels and crank arms should be cleaned. The cleaning of the shuttle box, toothed gearing and crank arms can easily be done either in the afternoon or in the morning just a few minutes before starting time.

If temple marks are observed on the cloth it should at once be remedied before it tears the cloth. If the weaver wants to produce the maximum of production from a loom, he must be ready to start the looms when the engine starts. He must value every minute and not spend half an hour over smoking a bidi or a cigarete at the latrines. He must not think, that if he is late ten minutes in the morning, ten minutes in the afternoon at starting time, and ten minutes more when he sits down for his meals, it does not matter. This one hour means a loss of 7½ yards of cloth a day per loom putting in 40 picks per inch and running 180 picks per minute. This wou d mean on two looms 15 yards of cloth loss, per day and in two days 30 yards which is equivaient to 1¼ pieces of say 8 lbs a piece. If the weavers' rate for this cloth is 8½ pies per lb., then the weaver loses about 7 annas in two days for two looms, and thi will amount to Rs. 5 and annas 11 in a month of 26 working days, which is a very big amount for a weaver to lose. Thus the loss in production means a loss in profit to the company too.

It is very essential, in the interest of the weaver as well as the company to keep a loom running by the next weaver in the absence of a weaver who may have either gone to fetch weft or book his production or to take his food.

A rocking loom, while in motion due to one or more of the loom feet working slightly loose, should never be neglected. It is a great saving of time if the weaver will occasionally watch the yarn as it passes from the back rest to the healds, and whilst the loom is in motion he can straighten out if he notices any crossed ends.

The warp should always be kept up straight at the back of the loom. The warp threads should not be pulled out of the lease rods as the threads will be liable to get crossed and patterned wrong if it is a coloured warp, and then get fast in the lease rods. The esult will again be a stoppage of the loom and a loss of production.

If the ends are sticking together they should be separated or any size cakes removed from the yarn, should a thread break not to let it get entangled with others between the reed and healds or become fast in the lease rods behind. If it does get entangled with others, more threads are sure to get broken, then a greater loss of

time is caused by drawing in the increased broken threads. When piecing up broken ends or threads weaver's knots should be practiced. If a selvedge is not weaving nicely the jobber or the head jobber must be informed about it at once, so that it may be made right. A good selvedge on a cloth both improves the appearance and ensures the other threads in the warp weaving better. When a cop becomes about half finished it should be pushed nearer the shuttle tongue end to prevent pulling in at the selvedge. The warp beam at the back of the loom should be carefully watched to see that the selvedge ends do not warp round or get fast against the beam flanges.

The weft must be caught when nearly finished before it breaks, as this saves finding the pick, and in some cases prevents making a broken pick. It also avoids letting slack, which may either make a thick place by letting back the taking-up wheel too many teeth or else it may make a crack or thin place in the cloth by not letting the wheel back a sufficient number of teeth.

Particular attention should be paid to weaving of narrow cloth in broad looms. This should be avoided as much as possible. It is one of the great factors that affects the weaving outturn and the wages of the weavers, jobbers, and head jobbers, if they are on piecework, unless they are paid on the speed of the loom.

The officer in charge of the weaving shed should try and encourage a feeling of co-peration between the weavers and the jobbers under his control.

How to Increase Production.

If all the foregoing details (given under Hints to jobbers and weavers) are very carefully observed and attended to both by the weavers and the jobbers, the production is bound to be greater than that of a jobber who is careless, and would not value, or ignore, the above details. The lesser the loom is stopped the greater the length of cloth woven, hence the weaver being on piece work will get greater wages. He would adhere to his looms, the jobber and the head jobber will also draw good wages. He (jobber) will have no trouble in getting the best of labour, and produce the most and best of cloth in every respect which will have an easy sale in the market, and fetch the top price.

Mottoes for the Weave Room.

Cleanliness, economy, efficiency, less cost, greater and better production are fit mottoes for the weave room.

If all the working parts are carefully cleaned, especially the bearings, it is sure to be better in their working. If all the bearings are allowed to get clogged with dirt, grit, and hard oil, there is bound to be a stiffness about it which prevents smooth running, and also sometimes causes the loom to be troublesome to both the weaver and the jobber. All working parts should be well oiled, that is, all the parts, where friction is created by two metals working against each other, should have just sufficient oil put on to always keep the parts moist, they should never be dry. All oil holes should be kept well cleared, so that a few drops of oil may be put in regularly.

The care of machinery ought to be a subject of great importance, and not an exhibition of careless indifference, reflecting great discredit on those who are in charge.

To maintain looms in good repair and order the attendant must possess patience, determination, perseverance and system. The company that employs jobbers of the above type will not fail in the least to make a good profit. The management should also look after them. A little friendly rivalry between the various jobbers is not bad, and an attempt should be made to inspire each with the desire to be first in his work and production.

A Specimen of

Observation Plan to increase "Efficiency" and "Reduce Cost"

Date................19

Kind of Loom—Plain. Counts of yarn T.68—W.72.

Time observed....7 A.M. to 5 P.M.

Width of Loom....50″. Reed and Pick..(per inch)..80 ×120

Humidity Dry....Wet......

Rel: Humidity......

Description of cloth..Sheeting R.P.M...180 No. of hours tested..9

Quality No.....1065. Loom hours...363. Tested By..........

Loom No.	Weak thread body.	Weak thread Selvedge.	Loose ends coming up body.	Loose ends coming up Selvedge,	Slub in yarn,	Loose cotton spun in	Bad piecing from Spinning.	Knots (winders)	Slip Knots.	Kinks.	Soft yarn.	Slack thread body.	Slack thread Selvedge.	Crossed ends.	Stoppage due to weft breakages.	Machanical Stops.	Cut by Shuttles.	Pick out.	Yarn Softly Sized.	Yarn harshly Sized.	Yarn under Sized.	Date when baam was Sized.						Percentage.	Total Stops per Loom.
1	II	II	I						III		I				II	I		I										90	13
2	III	I		I					III		I				III	II		II										85	15
3	III		I					I							I	I												94	7
Total	81	20	10	1				1	31		20		9	1	36	10		36	2									93	280

Total Loom Stoppage =280 Total Loom Stoppage per hour. ..77.

Efficiency.

In the sheds containing ordinary looms, the efficiency will vary from 81.9 to 83.0 per cent., but in a shed in which Dhoties (particularly if all are fancy with two or three borders) the average efficiency should not be under 75.5 per cent. The efficiency in a shed where mostly grey cloth is working, should be about 80 per cent. The low efficiency on Monday morning (or a day after a stop day) is largely due to the effect of the week-end break upon the operatives, the material, and the conditions of work. There is also a reason for the production or efficiency to be less during the first half of the day owing to the fact that the operatives begin work before having a substantial meal.

Efficiency in the weaving shed of the cotton industry is the resultant of many factors, some of which act directly upon the materials used in the manufacturing process, while others affect production indirectly through the working capacity of the operatives. The situation is further complicated by the existence of factors such as temperature and humidity, which have a direct effect upon the yarn used in the weaving and an indirect effect upon production through their effect upon the operatives. Efficiency in weaving depends upon the number of loom stoppages and the ability of the operative to attend to these stoppages in a quick and efficient manner. If the number of yarn breakages is increased by the action of the physical factors or by changes in the shed temperature or humidity, efficiency of production will be decreased accordingly. A similar result will follow from a reduction in the working capacity of the operative. The particular difficulty to be met in weaving is that factors such as temperature and humidity often tend to increase production by reducing the number of yarn breakages, but at the same time tend to decrease production by acting unfavourably upon the working capacity of the operatives.

Inferior warp and weft will always reduce the efficiency of the looms, easily proved by the defects in the woven cloth, which shows clearly the number of warp breakages. In such cases the efficiency can often be increased by reducing the speed of the loom from say 200 picks per minute to 190 picks per minute several methods have been introduced to help in weaving twist that breaks frequently, such as tying wet rag across the beam etc. The best modern mills manufacturing plains, twills, sateens, poplins, and fancy dobby cloths in the grey, do not exceed an efficiency of about 75 per cent.

In the coloured trade an efficiency of about 60 per cent. is considered very good. On the other hand mills having Northrop looms have an efficiency of 98 per cent in the grey trade and 85 per cent. in the coloured trade. 20 to 24 looms to a weaver.

Split Cloths.

In an ordinary loom two narrow cloths are woven according to its width. Thus a 54- inch loom may weave a cloth with a few empty dents at the centre and four ends of 5/40's (well twisted) are worked on the gauze principle at the edge of each selvedge to fasten it firmer than could be got by ordinary lifting, and thus prevent fraying after they are severed from each other in the finishing process or on the loom. This is obtained either by means of a split motion or a chain specially made for the purpose. The weft threads are then slit along the space by an aluminium cutter which contains a sharp blade (safety razor's or a similar one's). It rides on the woven cloth close up against the loom breast, and thus about 26″ wide cloth is obtained on each side.

Power.

3 to 4 calico looms 45-in. Reed Space to 1 I.H.P.

Electric Drive.

7-50 B.H.P. motors of 600/590 each, driving two line shafts through Reynold chain and reduction gear at a short distance and at reduced speed of 180 R.P.M. The motors should be centrally situated driving two line shafts and four lines of looms and 36 looms on each line.

Cleaning and Oiling Looms.

The cleaning and oiling of weaving machinery and the keeping clean of a weaving shed are matters worthy of the close attention of all connected with the industry. The importance of having this work well done cannot be overlooked, because cleanliness and lubrication directly affect running costs, upkeep of machinery, the work of the jobber, the quality of production, and the presence or otherwise of black oil stains on the cloth. No matter whether the cleaning, etc., is to be performed by the weaver or by a regular staff cleaner, each person should be carefully trained to do this particular work, and not merely allowed to come in and pick up a knowledge of the duties involved when a loom has to be cleaned after causing some damages.

All the cloth, warp, healds, shuttles, weft, etc., should be covered up with grease—proof cloth, which must be clean. Then, with a brush in one hand and a wiper or cloth in the other, the cleaner proceeds to sweep the loom, beginning at the top parts and gradually working down to the bottom. After this, the floor should be carefully swept. All dirty oil should be wiped off the loom, and any oil holes needing the attention should be picked clean. When the loom has been cleaned, it should be carefully oiled. Such parts as the crank arms and picking tappets and bowls should receive sufficient oil, but the cleaner must remember that any excess of oil is likely to be splashed on to the warp, resulting in serious damage to the product.

"The Automatic Loom."

There are two types of automatic weft-replenishing looms. One type is the shuttle-changing loom and the other is the bobbin-changing loom. The former changes the entire shuttle when exhaustion of weft is indicated, whereas the latter runs one shuttle continuously and changes only the bobbin in the shuttle when the weft runs out.

The shuttle-change automatic loom is made with a magazine which holds a reserve supply of shuttles. These shuttles as well as the bobbins and cops used are of a particular type. This loom, therefore, lends itself readily to existing spinning conditions. No change of the spinning equipment is called for, neither is it necessary to make any special allotment of the number of spindles to be run for automatic or non-automatic looms where these looms are being run together. The weft is the same in either case and interchangeable, and exactly the same shuttles are used on both looms. Every mill, therefore, can use the style of shuttle and bobbin that it is accustomed to. The bobbin are inserted on the shuttle tongüe, and the shuttle is threaded before it is placed in the magazine. The exhaustion of the weft is indicated by the weft fork, and the loom immediately stops. The empty shuttle is ejected, a fresh shuttle is conveyed from the magazine into the shuttle-box (while the loom is at rest), and the loom starts up again, continuing in opeation until the next time for changing the weft or a stoppage results from some other cause.

The bobbin-change loom is equipped with a circular battery holding a reserve supply of bobbins. These bobbins are of a special type in that the butt end of each is wound with three or four steel

rings. These rings conform to the spacings or grooves in a metal bobbin catch or spring in the shuttle, and it is the dovetailing of the rings in the bobbin with the grooves in the shuttle spring which holds the bobbin in position in the shuttle. When the weft fork indicates the change of weft, a bobbin is propelled from the battery into the shuttle, and as it enters the shuttle it forces out the spent bobbin through the open bottom of the shuttle into a receiving can placed under the sley end. The change of weft is effected without any stoppage in the weaving functions, or in other words, it is done in the brief period of time when the shuttle is at rest in the sley and prior to its being picked across to the other side of the loom. It will be noted that with this type of automatic loom a special type of shuttle and bobbin is required. Therefore, it will be necessary to make arrangements in the spinning department to meet this changed condition. This weft supply is not interchangeable with the non-automatic loom, special spinning conditions being necessary with installations of this type.

In addition to the mechanism required for the automatic change of the weft, automatic looms are supplied with a warp stop motion, which is a mechanical device that stops the loom immediately upon breakage of a warp end. Each individual strand of warp yarn hangs upon a little steel detector or drop wire usually drawn in in, two rows of the width of the warp. Underneath the drop wire is a moving vibrator bar which operates in a reciprocal way backward and forward without touching any of the drop wires but immediately underneath them.

When a warp end breaks, the drop wire falls into the way of the vibrator bar and arrests its action so that by means of a spring a knock device operates upon the loom handle and the loom is thus stopped. The weaver then has to piece the broken end and restart the loom.

Selvedges.

A smart, even, and well-woven selvedge usually denotes a smart cloth, and nothing looks worse than a piece of cloth with a rough selvedge. The selvedge on a piece of cloth is of great importance when, the cloth has to be finished in some way or other.

The bleacher, dyer, printer or finisher depends on a good selvedge to get the goods through his processes. Many thousands pieces are damaged through bad selvedges. A selvedge requires to

be strong, elastic, and of a suitable weave. Strength is necessary in order to avoid tearing during finishing, elasticity to ensure that the body of the cloth takes its share of the strain, as, if tight, the selvedge is liable to split.

"Boat" Selvedges in Twills and Sateens.

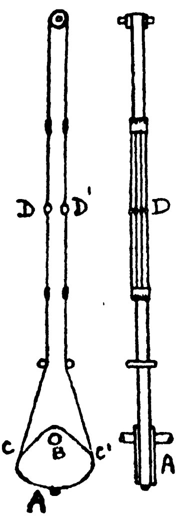


Fig. A.

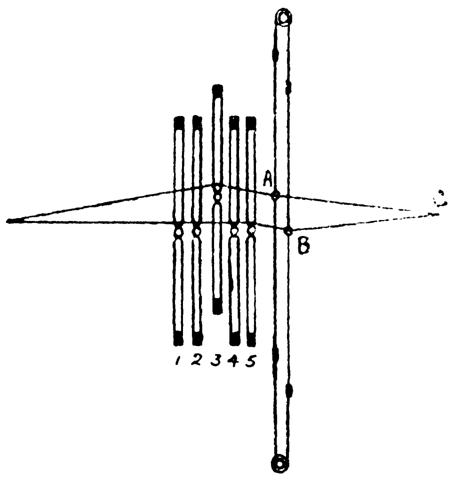


Fig. B.

Stave	3	up	=D'	up,	lifting	all	threads	in	staves	3, 4, and 5.
,,	4	,,	=D'	,,	,,	,,	,,	,,		3, 4, and 5.
,,	5	,,	=D'	,,	,,	,,	,,	,,		3, 4, and 5.

If it is desired to weave a selvedge on a twill as near plain as possible as given in the arrangement for the sateen just as shown above, then the selvedge threads should be drawn in the "boat" in the following manner.

All selvedge threads from staves 1, 3, and 5 through D', and all selvedge threads from staves 2 and 4 through D, giving the following result in cloth.

Stave	1	up	=	D'	up, lifting	all	threads	in	staves	1, 3, and 5.
,,	2	,,	=	D	,,	,,	,,	,,	,,	2 and 4.
,,	3	,,	=	D'	,,	,,	,,	,,	,,	1, 3, and 5.
,,	4	,,	=	D	,,	,,	,,	,,	,,	2 and 4.
,,	5	,,	=	D'	,,	,,	,,	,,	,,	1, 3, and 5.

the weave being $\dfrac{1—1—1}{—1—1—}$

If the selvedge threads are so arranged in the boat that a two up, three down weave is the result, as in the first example for the twill weave, then it is advisable to draw the last five ends of the selvedge nearest to the edge of the cloth in the healds in the ordinary way without the use of the "boat" this one repeat making quite an efficient "Catch end" arrangement.

Use of Pulleys.

In Fig. B. will be found another arrangement in which just pulleys are used, but the selvedge threads are arranged in A and B in the same way as D and D' of the "boat". The eyes of A and B are fixed between the healds and the front rod C in a convenient place, but sufficiently near to the healds to give a reasonable height of shed.

When twills or Sateens are being woven, a good selvedge, very nearly plain weave, may be made by the "boat" arrangement as shown at Fig. A. It is usually a simple piece of wood A, made by a carpenter or joiner, and fixed on a peg B which is bolted to the frame work of the loom behind the heald staves and below the level of the warp. Straps C and C′ are bolted to the "boat" and are connected by buckles up to a few healds D and D'. The "boat" is generally about two inches to three inches long, and its exact shape is not important.

Selvedges for Sateens.

If weaving a 5-end Sateen, one up, four down, then the selvedge ends which are to be drawn through staves 3, 4, or 5, are first drawn through the eyes D′ and the selvedge ends intended for 1 and 2 staves are first drawn through D. Each end is then drawn-in to its proper staves but over the heald eye, (not through the eye,) and a weave very near plain cloth will be result. If either staves I or II are lifted, then the boat swings with D up and D′ down. Thus, if the weave is 1—3—5—2—4, then the following will be the working of the Staves.

Stave	1	up	=	D up, lifting all threads in Staves						1 and 2.
,,	3	,,	=	D′	,,	,,	,,	,,	,,	3, 4, and 5.
,,	5	,,	=	D′	,,	,,	,,	,,	,,	3, 4, and 5.
,,	2	,,	=	D	,,	,,	,,	,,	,,	1 and 2.
,,	4	,,	=	D′	,,	,,	,,	,,	,,	3, 4, and 5.

Twill Fabric Selvedges.

If weaving a twill, then the ends from the five Shafts may be drawn in the boat in the same order, and the resultant selvedge weave will be.

Stave 1 up = D up, fifting all threads in staves 1 and 2.
" 2 " = D " " " " " 1 " 2.

CHAPTER XXXV.

DROP BOX LOOM.

The drop box was invented and applied to the hand loom about 1760, while the circular—box motion, as applied to power looms, was invented in 1843.

When it is desired to weave a cloth in which it is necessary to place more than one kind of weft, a method of inserting the weft must be employed different from that in a loom, which only carries one box at each end of the sley, and can thus only accommodate one shuttle during weaving.

Looms constructed for this class of work are known as Box Looms or Check Looms. All methods operating the boxes in a box loom are based on one of two leading principals of governing shuttles; namely the drop—box motion and the revolving,—or circular,—box motion.

Drop boxes are generally operated by levers and other suitable mechanism, so as to bring the bottom of the desired box in line with the race board of the loom., and thus allow the picker to act upon the shuttle contained in that box. By this means several shuttles, each containing weft of different count, quality, class or colour, can be operated, and the one to be used at any given time is selected automatically.

Box looms are designated by stating the number of boxes at each end of sley, thus 4×1 box loom and the number of shuttles that can be operated in a 4×1 box loom is one less than the total number of boxes.

Various kinds of cards used on drop box looms are as follows:—

0 × 0 × .	Box 1 to 2 and *vice versa.*
. × 0 × 0	Box 1 to 3 and *vice versa.*
. × 0 × .	Box 1 to 4 and *vice versa.*
. × . × .	Box 2 to 3 and *vice versa.*

0 × . × .	Box 3 to 4 and *vice versa.*
. × . × 0	Box 2 to 4 and *vice versa.*
0 × 0 × 0	No change either in Boxes or the reversing barrel.
0 × . × 0	No change in the boxes but acts on the reversing barrel.

The first object to attain in a box loom is the timing of the boxes in such a manner that they will not start to change before the shuttle is well into the box, and will be completely changed before the loom begins to pick. This is very essential, since, if the boxes begin to change before the shuttle is well boxed, the shuttle will be caught in the mouth of the box, and will thus prevent the changing. On the other hand, if the loom commences to pick before the boxes are completely changed, the bottom of the box will not be levelled with the race board when the shuttle is thrown. The safest method is to have the boxes just beginning to move when the crank shaft of the loom is on its top centre. This gives a full half revolution for the change to take place and to steady the boxes before the commencement of driving a shuttle across the loom.

Power.

The power required to drive a box loom is necessarily somewhat in excess of that required to drive a plain loom, owing to the additional motions brought into use. 2.75 looms equal one horse power.

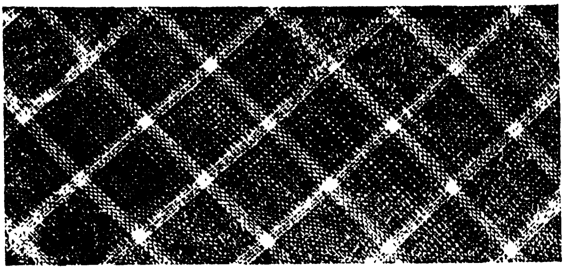
Speed.

A good speed for Drop Box Looms may be anywhere between 140 and 160 picks per minute.

Circular Box Loom.

Circular boxes are used only in conjunction with loose reeds, and for light or medium weight fabrics. The ease with which they can be operated, however, enables the loom to be run at the maximum speed.

Check Designs.



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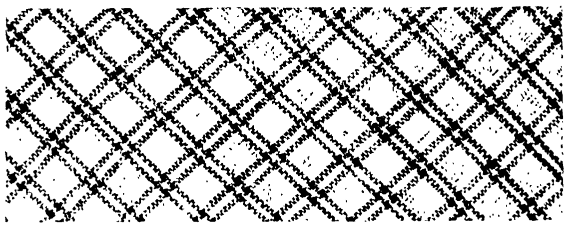

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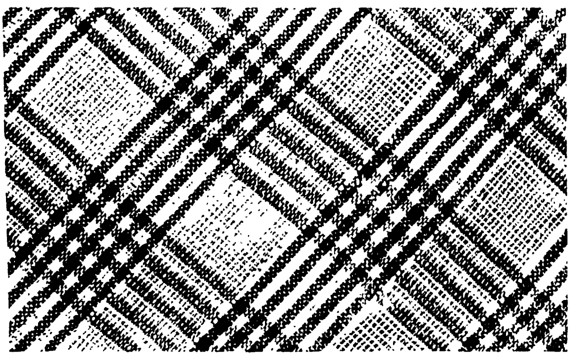

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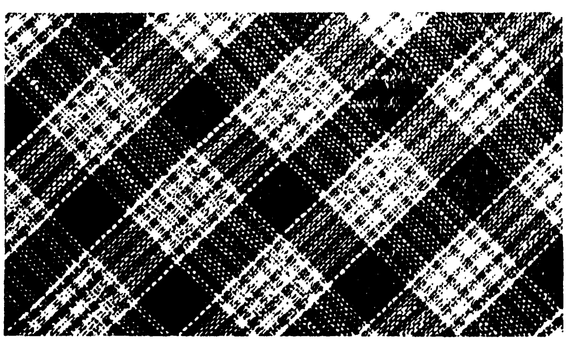

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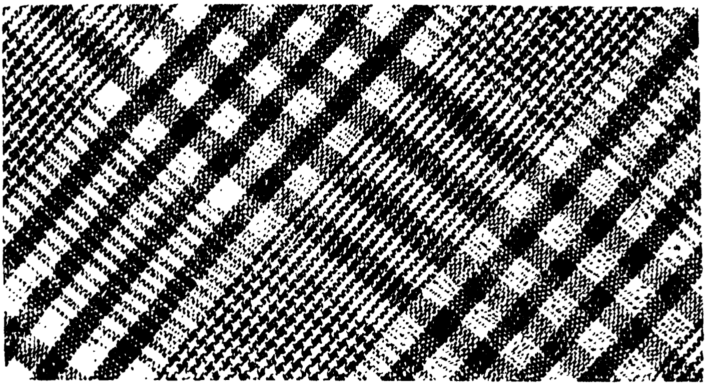


No. 5.

WEFT ROOM.

Notes for the Weft Room.

(1) Not to allow looms stand for weft; (2) not to receive bobbins quarter or half full, back from the weavers. These bobbins, which are eventually submitted most mercilessly to the hoop iron in the shape of a knife, become forever afterwards a nuisance both to the spinners as well as to the weavers. Bobbins should, under no circumstances, be allowed to be cut; if necessary, they may be cleaned by means of a bobbin cleaner or by hand or rewound on the universal winder; (3) not to allow the bobbins to get mixed up.

The weft clerk or the man in charge of the weft rooms should possess a thorough knowledge of his responsibility, besides he must run his department by the exercise of forethought. He must always be persistent in his demands as to his requirements, so that he may keep his department well provided with all that is necessary for the day, and thus not allow even a single loom to wait for weft. The man in charge of the weft room must bear in mind that the spinner cannot change his frames at a moment's notice, though the spinner may happen to have a surplus of roving bobbins.

Particulars as given under in the table must be prepared daily and a copy submitted to the Spinning Master.

Daily Requirements of Weft.

Counts and Description	No of Looms Working	Quantity required per Loom per day.	Total requirements	Quantity in Stock.	Remarks.

The weft room should be provided with a wrap reel, a scale and a testing machine.

The best time to test the weft is as it is being receïved in the weft room. One or two bobbins may be taken at random from each skip, and tested. Because, if the skip is wrongly ticketed, it will be discovered before any harm is done. Should there be found any serious mistakes or inaccuracies in the wrappings they must be intimated at once to the Weaving Master or the Manager, otherwise the consequences will certainly be serious owing to the pieces coming either too light or too heavy, and which, if woven will be too late to remedy.

The arrangement of the weft room should be such that the men working in it must be afforded all conveniences connected with their work that is, there should be plenty of accommodation for receivig the weft, stocking it, and returning back the empty skips without causing delay and confusion. No weaver should be allowed to enter the weft room. No weft should be issued to the weaver unless he presents his ticket or board to show the counts of weft he is using.

CHAPTER XXXVI.

DOBBY MACHINES.

For some years following the introduction of power weaving in its application was slow, but, early in the nineteenth century, many factories began to use Cartight's invention. It became apparent that the power-loom was necessary to the efficiency of the textile industry, and many manufacturers, recognising its possibilities, proceeded to utilise it for the highest class of fancy weaves, mounting it with ingenious pattern—forming appliances, by supplementary warps and other contrivances. Patterns of the most elaborate kind were woven, and, when the Jacquard apparatus came to give the warp a mobility equal to that of the weft, the circle was completed, and the power-loom became an instrument of art far surpassing the finest hand-loom.

The gradual application of the power-loom gave a considerable impetus to the development of mechanical devices with a view of facilitating the operations of the loom. Attention was directed to the perfecting of existing motions and the invention of new ones. Among these were methods of manipulating the warp. One of the earliest and simplest of these was the tappet motion, which ultimately proved suitable for weaving materials requiring from four to eight healds. It was recognised, however, that some simple device was necessary which would enable a wider range of patterns to be woven without necessitating the use of a Jacquard machine, but it was not until 1858 that Railton and Lang, both of Blackburn, introduced what was ultimately developed into the "Blackburn" or "Shorrocks" dobby.

Fig. 1.
Double Jack, Double Lift, Single Barrel Dobby.

With a few exceptions such as, heavy goods, tappets are not generally used in cotton weaving when the pattern to be produced requires more than six or eight shafts of healds, and as many picks to the round. Above that number dobby machines are employed. These are now constructed upon principles which secure steady and reliable working, and permit of higher speeds than were possible with the older tappets, which combined fairly large heald capacity with facility for effecting changes of pattern.

In the cotton industry, dobby machines are used up to sixteen or twenty shafts of healds, although an increasing use is made of larger dobbies upto 40 shafts for additional figuring capacity in view of the introduction of the double jack in this size and even multiple barrels. There is practically no limit to their capacity as regards number of picks to the round or repeat.

There is an infinite variety of dobby machines in use, both for general and for special purposes. They range themselves, however, into types, which may be described as positive and negative in action, and further sub-divided into single-lift, single jack, single-lift double jack, double lift, double jack, double-lift single jack, and the pattern capacity may be increased by the addition of barrels worked either by hand or automatically. The pattern may be determined by pegged lags.

Single-lift machines are these in which there is a single lifting agent (generally known as a "griffe") for the whole of the shafts. It is therefore essential that the whole of the latter should be returned to their original position, along with the griffe, after each pick, to enable a fresh selection to be made and lifted for the following pick. Such a method of working also gives a "closed shed" so termed because the shed is completely closed, that is to say, all the warp threads are brought to a common level after every pick of weft. On account of there being only a single lifter, the machine, and therefore the loom, cannot be run at a speed of more than 130 or 140 picks per minute, hence this type is only used on slow looms such as, those for wide or heavy cloths. This machine can also usually be arranged to give a "positive" control over the movements of the healds by connecting top and bottom shafts to separate hooks which work opposite to one another; that is to say, when one is pushed over the griffe to be lifted, the other is pushed away therefore thereform. In by far the great majority of cases, however, dobby machines are "negative" in their action: that is, they only operate

to move healds in one direction, and require supplementary parts (such as, springs, weights, or other motions) to bring the healds back after their action upon them.

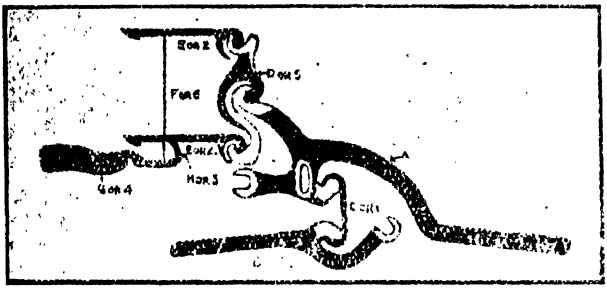


Fig. 2.
Shewing Arrangement of Levers, in Double Jack, Double Lift Dobbies.

In double-lift dobbies the selecting and lifting parts of the machine are duplicated, so that it is possible to begin and form a new shed immediately the preceding one begins to close; also the parts move at only half the speed of the loom. The result is a considerable saving of time and of power, which makes it possible to increase greatly the shed of the loom. Double-lift machines are either open sheds or semi-open sheds, the latter type also being sometimes called 'centre' sheds.

In open shedding, a heald shaft once lifted remains up until its warp threads are required by the pattern to fall again. The standard machine of this type, which has practically displaced all others constructed on the same principle, is one in which the hooks and draw knives or griffes slide horizontally and act upon a ⊣ — shaped lever, whose centre remains stationary in the advanced position, notwithstanding that its ends, to which the hooks are attached, may change positions on successive picks.

The most popular model of this type is that made by Richardson, Tuer & Co., Ltd. of Farnworth, England.

In the semi-open or centre-shed dobby, a hook and its attached heald shaft falls with its griffe until the rising hook and griffe come in level with them, whereupon the shaft—supposig it to be so required by the pattern—is taken up again by the ascending hook and griffe. The standard machine of this type is that known as the

Shorrocks dobby, in which pegged lags come into direct contact with vertical hooks (of which there are two sets, each set acting upon the same set of heald jacks) to determine their position with respect to the griffes, which rise for alternate picks. There are also two chains of lags, namely, one for odd and the other for even picks—an arrangement that sometimes causes trouble by the lags getting out of their proper sequence. In an improved dobby of this type, there is only one set of lags which is a decided advantage. This semi-open shed dobby is largely used for leno fabrics on account of the facility for 'shaking' or bringing crossing and crossed warp threads level, but apart from this class of fabric it is not at all popular, the extra wear and tear on, not only the dobby parts but also on the warp and healds, definitely rule it out of consideration as a general utility machine, and the standard type open shed dobby referred to in the preceeding paragraph, when fitted with simple attachments, is equally capable of the production of leno effects besides an enormous range of others.

Cross-border dobbies are used when a change of weave has to be made in towel headings, or for bordered handkerchiefs or serviettes. In a single-lift machine this is easily provided for by adding one or two extra rows—according to the number of weaves required—to the card cylinder, and bringing the rows opposite to the hooks as the pattern punched upon them is required. In the double-lift machines of the horizontal type, an additional barrel and set of lags is provided which are extended over the second barrel. The change of barrels can be effected either by hand or automatically to the design of attachment fitted in the dobby, but the general tendency is strongly in the direction of automatic attachments due to the much wider scope at comparatively a little extra cost obtainable therefrom.

Experience over a period of longer than 50 years has firmly established the practice, amongst the best manufacturers of textile machinery, of completely dismantling dobbies before shipment, and then packing them in parts for export. This method is actually economical compared with the packing of dobbies in their erected state, for, when dobbies are dismantled, there is far less liability of breakage; furthermore, savings are effected in the costs of packing cases, freight, and insurance which more than offset the costs of dismantling at makers works and subsequent erection at mill.

On the arrival of the dobbies in packing cases at destination, the greatest care should be taken in unloading, unpacking and handling them. Instead of being tipped off the vehicle which

carries them, as is unfortunately not uncommon practice, the packing cases should be gently lifted down to avoid any shock to the contents. Such care is well worth while, for it prevents serious breakages and damage which, oft-times not being replaceable or repairable quickly, result in both loom and dobby being out of commission—a serious loss which cannot be overestimated.

The first necessity in re-erecting a dobby is the provision of a perfectly squared-up bench or surface table on which the work should be carried out; this ensures the two dobby sides being re-assembled dead square with each other just as they were, before dismantling, at Manufacturers Work. The exact position of the rails and grates will be obvious from the paint marks left on both the dobby sides; such positions should be taken up again without the slightest deviation.

The inner jack shaft should now be inserted, and the inner jack levers slipped on it in the exact order in which they were tied up. All internal levers, by the way, before the dismantling process at makers works, receive a white paint mark diagonally over them; this shows clearly the correct relative position of every lever to each other, so that if, through carelessness or accident in unpacking, any lever loses its right position, the fact is at once made obvious by the paint mark to the assembler. In this way, rectification can be made in but a few seconds. Immediately following the insertion of the inner jacks, the inner jack bolt should be slipped in position, after which the outer jack levers should be put into the machine followed by the 'S' levers; then the wood grid should be fitted, the peg levers inserted, also the bottom catches; their respective guards being immediately fixed in position. The dobby needles are then ready for putting in, and as they are all of standard length and interchangeable with each other, no particular order for their insertion need be observed. It is important, however, to see that the holes in the top and bottom catch grates are in perfect alignment with each other so that the needles may move freely in both of them when resting on the peg levers. Should the slightest 'binding' be noticed, a slight tap on the offending catch grate will be sufficient to remedy the defect, after which both catch grates should be properly tightened up. The top catches should now be inserted, and the respective guards fitted.

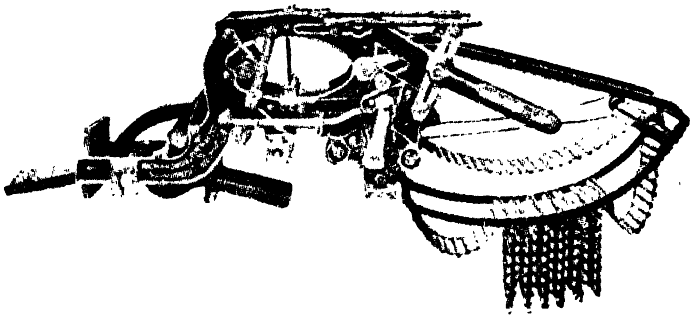
The three setting-up screws on each dobby side should now be slackened a little, but before doing so, it is worth while to measure and mark the distance they project through the dobby side, so that the same position can be taken up by each of them when the dobby

is finally assembled ready for mounting. To correctly test the accuracy of their position, it is essential that the catches and each corresponding outer jack lever are in true alignment with each other, furthermore, that the outer jack levers are neither too tight nor too slack.

The main shaft should now be slipped in position, the tee lever attached to it being already complete with Knife End Bolts for attaching to the Knives, and the Straight Driving Lever being similarly complete for the opposite side. When the key in the straight driving lever has been tightened up it is necessary to observe that the tee lever has a perfectly free movement in all positions. If there is any 'binding,' first see that the bosses of the tee lever and the straight driving lever are not drawn too keenly against the dobby side. The Top Shaft Bush should be set to project slightly through the Dobby Side to enable the levers to be keyed against it.

To test at this point whether the dobby has been properly set up, lift the tee lever so that the top knife is at the front end of the slot, then press down the whole of the catches, so that the whole of the outer jack levers may be lifted. Whilst the bottom knife is forward the bottom catches can be held on to it, and then, by raising the tee lever the outer jack levers can be held up by the bottom knife. Whilst the bottom catches are in this position, it is as well to again test the needles to make sure that none are binding. When the tee lever is lowered, each outer jack lever ought to drop cleanly in the slot of the outer jack grate and, if any stick, the same cause will probably be found to be due to the grate not having been fitted squarely.

The links may now be attached to the outer jack levers and the inner jacks to the links. Provided that the whole of the internal levers and links have been put into the machine in exactly the same order as they were tied up after dismantling at Makers Works, no necessity will arise for any levelling-up process. The bolt which goes through the outer jack levers, and the one which goes behind the links should now be put in; finally the barrel which is fitted complete with wheels and brackets set in their proper positions. After the brackets have been fitted to the dobby side to obtain the necessary clearance between the barrel and peg levers, the 'setting-up' process is complete, because the push catch need not be disturbed on the straight driving lever nor should the set positions of the spring wheel and catch wheels on the barrel be in any way altered. It is only now necessary to attach the spring lever on the spring wheel for the dobby to be ready for mounting on the loom.



Double Jack, Double Lift, Double Barrel Dobby, with Extended Frame and Automatic Cross Border Motion. Special battice Carrier,

Fig. 3.

How to Mount the Dobby on the Loom.

The two dobby stands should be fitted on to the Loom Top in such relative positions as to ensure the dobby being mounted exactly in the centre of the loom, that is to say, the centre point between the end of the inner jack lever and the end of the outer jack lever should be immediately over the centre of the reed space. Accepting the dobby model A/O made by Richardson, Tuer & Co. Ltd., of Farnworth, England, as the most popular standard in India, the inner stand would be fixed $2\frac{1}{4}''$ from the centre of the reed space in the direction opposite to the dobby drive, and the outer stand would be fixed $28\frac{1}{4}''$ therefrom, *i.e.* $26''$ from the centre of the reed space in the direction of the dobby drive.

Before the stands are finally tightened up it is advisable to make sure that the full length of the chipping ribs are bedding firmly against the body part of the loom top, and also that the top portion of the foot is resting for its full length on the top of the loom top. The front portion of the stands, when mounted, should be $\frac{1}{2}''$ higher than the back portion; this ensures clean working of the dobby. A straight-edge should then be put across the front portions of the two stands and a test made for alignment with a spirit level; the same process and test should be repeated on the back portions of the stands. After any necessary adjustments have been made to bring the two stands on a perfect level with each other, both at the front and back, the dobby may be lifted on to them. The position of the dobby relative to the sley cap can then be set after which the dobby should be firmly fastened down in its proper position, the stay to the breast rail being fixed at the same time.

Timing and Setting the Single-Cylinder Dobby.

When the loom with a dobby attached is being started, all the motions connected to the loom proper should be set as on a plain loom before the setting of the dobby is attempted. Although the setting of this part of a fancy loom may seem to be a difficult problem, it will, after it has been carefully studied, present not very great obstacle. Each part of the dobby has an exact setting, which bears a definite relation to some other part of the loom and, if these parts are set in their proper relation to each other, the dobby will be found to be exact in its action as a whole.

Starting of a Dobby.

When coupling up the connecting rod to the crank fixed on the extension to the bottom shaft, the loom should be turned to such a position that the loom crank would then be on the top centre and the dobby crank in a horizontal position. The tee lever of the dobby should also be horizontal, and in this position, the connecting rod may be fixed. Where possible, the connecting rod should be attached to the third slot of the tee lever, and the necessary stroke obtained from crank at the bottom. The loom may be turned over by hand and it is necessary to watch that the knives do not touch the end of the slot when the tee lever is either up or down. If both knives touch, then the bottom connection of the connecting rod will have to be brought nearer the centre of the tappet shaft. If a greater lift is found on one knife than the other, this should be adjusted by altering the position of the connecting rod in the connecting rod bottom bracket. I desire to emphasise this point to impress upon all dobby users the fact that the knife-end bolts are properly set to length and clearance on the test bench in Makers Works, and ought not to be disturbed when the dobby is being mounted.

The lags and pegs ought now to be slipped on to the barrel to check over the necessary clearance between the lag and the barrel, and to check also the lift of the peg levers.

The dobby after this operation ought to be ready for weaving, and if care in assembly has been exercised, and all the nuts thoroughly tightened up, no further attention of any description ought to be necessary for many years.

Lift of the Healds.

The outer part of the jacks in all dobbies contains a number of notches, and the healds that are attached by the heald straps and wires to the end notches receive a greater lift than the healds

connected to the inner notches, since the outer part of the jacks will move through a greater space; consequently, it is the custom to attach the back healds to outer notches in order to give them a greater lift. It is possible to give a greater lift to the back jacks by setting the knives so that they slant slightly to the rear of the dobby, allowing the maximum clearance from the hooks at the front and the minimum amount from the back hooks. The slots in the dobby frame in which the knives move will allow of this being done; but if possible, it is always advisable to set the knives at right angles to the dobby frame.

How to Remove an Outer Jack.

Release the three setting-up screws sufficiently to allow clearance between the levers equal to the thickness of one jack. This can be done at either side of the dobby, those nearest to the jack requiring replacement being most convenient. Next remove the bolt which goes through the jacks and uncouple the link connected to the jack. The jack may then be freely lifted in the left hand and the "S" lever gripped with the right hand. A slight movement of the "S" lever is all that is necessary to disconnect if from the jack, when the jack may be moved bodily towards the outer jack grate and then lifted and pulled towards the dobby to get it clear of the machine. For this purpose it is not necessary to remove the catches from the"S" lever and if another jack is being put in immediately, the "S" lever may be left resting on the others. To replace the jack the method is reversed exactly, but when *tightenning* up the setting-up screws, again see that the side lever is bearing against the jacks, but not so hard as to prevent them working freely. This operation ought not to take more than two or three minutes to complete.

How to Remove an inner Jack.

First remove the bolt running behind the boss of the jacks, next remove the link, then the inner jack may be removed by lifting the inner end, and a slight movement towards the outer jack grate, until the lever is clear of the shaft, is sufficient for the jack to be withdrawn. To replace the jack the procedure is reversed.

To Remove an "S" Lever.

First slacken back the three setting-up screws on the dobby side nearest the "S" lever to be detached to give side clearance, then after removing the bottom catch the "S" lever may be disconnected

from the jack after the outer jack has been lifted. The top catch may either be removed with the "S." lever or previously detached. It is, of course, necessary to remove the catch guard.

To replace an "S" lever the operation is reversed but care must be exercised in fixing the setting-up screws, so that they give the requisite amount of pressure to keep the jacks in place but not so tight as to cause binding.

To Remove a Straight Peg Lever.

First remove the guard over the wood grid, and when the tee lever is in its bottom position so that the knife is at the front end of the slot, the peg lever to be removed is lifted up from the outer end, and bodily raised until the slot is clear of the shaft, then same may be drawn back clear of the dobby.

To Remove a Hooked Peg Lever.

First of all, remove the straight peg lever on each side of the hooked peg lever, then when the hooked peg lever has been lifted at the back end sufficient for the hooked part to be clear of the catch grate, one half turn of the lever is sufficient to enable same to be withdrawn. It is sometimes necessary to lift up the needles which were resting on the two straight peg levers. In the reverse way a hooked peg lever is replaced.

General Observations.

There are eighteen notches in both the inner and outer jacks, and these are sufficient to give the increased size of shed required by the back healds over the front healds. It is absurd to endeavour to set the knives to give a taper shed as this necessitates excessive strains on all bearings. The ideal position for the knives is just a minimum clearance between the back of the knife and the hook of the peg lever, and when the knives are set in this position there will be quite $\frac{1}{4}$ in. of the slot remaining at the front of the knife, and no risk of broken dobby sides by the knife banging against the end of the slot. $\frac{1}{8}$-in. is all the clearance that is required between the top of the knife and the underside of the catches. This enables the catches to drop cleanly on to the knife and eliminates any risk of the catches slipping off. When the catch is set at an excessive distance from the knife there is a great risk of the catch not resting solidly on the knife and any heavy lift would cause it to slip off. This

causes excessive strains when the "S" lever is pulled back with considerable force against the rail, and it has been known for this to be the cause of breakage of the jack shaft. To adjust the clearance between the bottom of the catch and the top of the knife, the position of the wood grid may be altered by moving the set screws holding same in their slots. When these set screws have been disturbed, see that the wood grid is perfectly horizontal, and then there is no risk of the peg levers rubbing hard against the wires and causing the peg levers to stick.

If the barrel has been detached, see that there is just the necessary clearance between the lags and peg levers, and also that the holes of the lags register truly with the peg levers. When this position is obtained the spring wheel is tightened up and the push catch is set by having the tee lever at the bottom of its stroke; the push catch is then in its forward position and the tooth of the catch wheel is set up against the push catch. It is not advisable to have more stroke on the push catch than would cover say, one and a half teeth of the catch wheel, and if this requires any adjustment it is necessary to move the push catch in the slot provided for same.

Hints on Cross Border Motions.

Two barrel motions with automatic change have many advantages in addition to the ordinary application for putting in different patterns in headings. In piece goods great saving of lags can be achieved where one portion of the pattern is the basis repeating a number of times before the pattern changes. As an example, supposing a check pattern is to be woven having 200 picks of warp satin, then repeat 200 picks of weft satin. This can be done by having ten lags on each barrel and repeat each barrel ten times before changing. The total lags required for this operation are thereby only 20 lags with pattern and 20 small lags on the measuring barrel, ten of which have pegs.

A further example may be illustrated in cloths of a border type where a small figure repeats say, 20 times, and then a single repeat, say of floral effect inserted. In this case just one repeat of the spot effect is pegged on one barrel and the floral effect is pegged on the other barrel, the number of repeats from each barrel being determined by the lags on the measuring barrel.

Dobby Faults.

The fault probably most frequently met with in connection with the dobby is known as stitching; that is, the failure of any one heald to lift when it should, and consequently the weft floating over

the ends drawn through that heald, when the weft should really be under those ends. This fault may be caused in several ways. A peg in the lags may become bent in such a manner that, when the lag in which it is placed comes under the feelers, the peg, instead of lifting the feeler that it should operate, passes between it and one of the adjacent feelers. In some cases the cylinder may be moved slightly to one side, thus throwing the pegs out of their proper positions, in which case some of the pegs may not lift their feelers. This fault can easily be remedied by loosening the setscrews that hold the cylinder in place, and moving the cylinder until the pegs in the lags come directly under the feelers. A short peg placed in the lags will sometimes produce stitching, since the peg will not lift the feeler high enough to cause the hook to become engaged with the knife. If for any cause one of the hooks should become bent, its action is very apt to become uncertain, since it is liable to become bound by the sides of the rack, or guide, through which it passes. In such a case, the hook will not fall when the feeler is lifted, and consequently it will not engage with the knife. In other cases, the hook may just engage with the knife, but slip off before the heald has received its full lift and the shuttle has passed through the shed. In any case where stitching is noticed, the ends that are affected should be traced from the cloth to the healds, in order to ascertain through which heald those ends are drawn. Then, by carefully watching the feelers and hooks actuating that heald, the cause of the difficulty will generally become apparent.

Power and Speed.

Since more healds are employed when using a dobby, more power will be required to drive the loom than is the case with the ordinary plain loom. The necessary power will also depend to a certain extent on the number of shafts or healds being used, but as a general rule it may be stated that when four plain looms are taking one horse-power to drive them the same power will drive only three looms with dobbies attached.

On some weaves it may be necessary to run the loom as low as 140 picks per minute, while on others it is possible to attain a speed of 180 picks. As a rule, when plain looms have dobbies applied the speed is reduced 10 to 20 per cent.

Jacquard Machine.

The Jacquard was invented by a Frenchman, Joseph Marie Jacquard, in 1801. It carries out the principle of shedding by an elaborately prepared harness which allows each warp yarn to be controlled separately, being lifted only as needed.

A jacquard machine and a thread harness are generally used in cotton weaving for patterns in which the warp threads require to work in more than 20 or 24 different ways. The principle of the Jacquard is very simple, namely, that hooks formed at the upper ends vertical wires can be allowed to remain over, to be pushed away from a lifting griffe, which is raised and lowered for every pick of weft by the presence or absence of holes in a paper card that is passed against the needles by a perforated cylinder. Each needle controls a hook, and both are arranged in rows, which vary according to the capacity of the machine. A tail cord or neckband is fastened to the bottom of each hook, and each cord has suspended from it a number of harness twines, which pass through the holes of a comber-board that keeps them straight, and opened out to the required width. Below the comber-board, "mail" eyes are tied upon the twines to receive the warp threads, and to the bottom of the twines lingoes or wires are tied to bring hooks, twines and warp threads to their original positions after they have been lifted by the griffes. The cylinder is pressed against the needles which project through a needle board and have springs at their rear ends to press them forward again after the action of the cylinder—once for every pick; and as it moves away from them the cylinder is turned a quarter of a revolution to present a fresh card facing the needles. This describes the "single-lift" machine which receives its motion from a sweep or crank at the end of the loom crank shaft connected to the griffe-ifting lever.

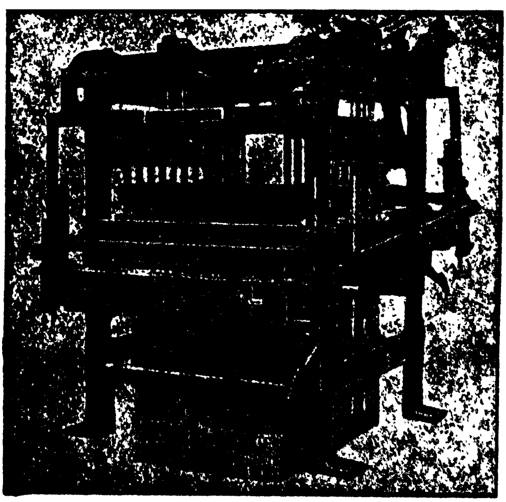


Fig. 4.
600s Double Lift, Double Cylinder Jacquard Machine with Swing Batten Cylinder Motion.

"Double-lift" machines are designed to give higher speed, and there are two kinds, namely, double-lift single-cylinder and double-lift double-cylinder. In the former case each needle controls a pair of hooks, which are tied to the same bunch of harness twines, and are capable of being lifted by a pair of griffes that lift for alternate picks of weft. In the latter case, hooks, needles, griffes and cylinders are duplicated, so that all the parts move at half the loom speed. Hence, the latter can be considerably increased compared with that of a single-cylinder machine. On the other hand, the double-cylinder machine requires the cards to be laced in two sets, one for odd-numbered picks and the other for even-numbered picks—an arrangement which sometimes causes spoiled cloth to be produced by the cards getting out of their proper sequence.

The greatest of difficulty has been experienced for years in devising a satisfactory method of packing Jacquards for export. Obviously, it is not practical to dismantle them so that they can be shipped safely in parts. Unfortunately, therefore, the necessity exists in shipping them in their erected state, and it is, in this regard, that serious trouble arises, for very considerable breakages usually result, which, besides being expensive in themselves, delay the mounting of the Jacquard on the loom.

A new and much improved method of packing, however, has-been perfected by Messrs. Richardson, Tuer & Co. Ltd., the well known Jacquard makers of Farnworth, England, and this should prove a boon to Indian mills.

Jacquard machines for export are usually packed two in a case, being wrapped in canvas so as to keep the packing material clear from the working parts of the Jacquard.

When lifting out of the case, which will, not doubt, be done by power, care should be taken that the chains are put between the spindles on the inside of the machine.

The driving motion, which is packed separately, is only fitted to the machine when it is in fixed position on top of the loom or rafters. After correct adjustment has been made, flats should be put on the shafts to enable the setscrews to get a good hold.

An important point, before working the Jacquard, is to see that the cylinders are perfectly in line with the needle boards.

The spindles and slides of the machine should be kept regularly oiled; but to prevent dripping of oil and consequent damag to the cloth, oil drippers should be attached underneath the spindlees.

When harnesses are supplied with Jacquards, it is necessary, before putting them into the loom, to see that plenty of french chalk is rubbed on, so as to prevent any possibility of sticking in the board.

A very good feature of the method adopted by Messrs. Richardson, Tuer & Co. Ltd., in shipping harnesses when ordered with Jacquards, is to ship them separately. In this way they carry much more safely, cost less in freightage, and through the medium of what are known as "loops, links and cord board" can be attached in a very short space of time to the Jacquard when mounted on the loom. The comparatively small cost of this feature is well worth while.

JACQUARD MOTION.

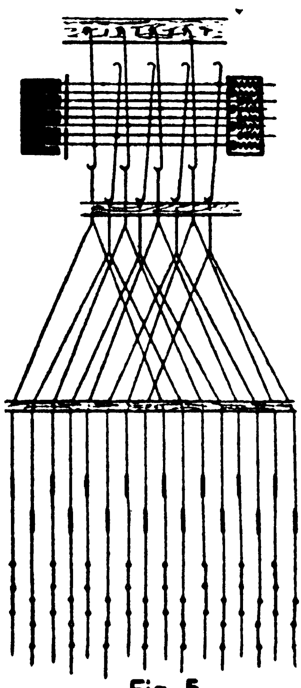


Fig. 5

In the above figure 5 it will be noticed that the hooks are held upright by rods connected by spiral springs, a card pressing against the ends of these, pierced with holes opposite the ends of the rods connected with the required hooks, the arrangement of holes in the card thus determines the pattern which is woven.

CHAPTER XXXVII.

MANUFACTURING PARTICULARS.*

Study Card Serial No. ....

Date................194

Description..................................

Dimension......Ins.........yds........lbs......

Reed........Pick........Twist........Weft ....

Appearance..............Kind of Finish..........

Colour..............Variations ....

Width............Variations......................

Length................Variations................

Weight................Variations...............

Kind of Weave............Variations............

Character of yarn..............................

Warp.................Weft....................

Cost Price..............Selling Price.............

Use.-

Place and date of Purchase......................

Remarks.

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*The card is $6\frac{1}{4}$ inches $\times 8\frac{1}{2}$ inches. Leave a space of about 3 inches at the left for pasting sample and if possible the drafting and pegging plan.

The Textile Designer.

It requires a great deal of knowledge, ability, labour, time and expenditure of money to design and make a new textile material that will be accepted by the consumers. The Textile Designer often works at a great advantage, in that although he is largely limited to working in threads crossing one another at right angles,

by interlacing of these he can produce different textures which he can vary in conformity with the desired ornamentation, which may be based upon.

The Stripe,
The Diagonal,
The Check,
The Spot, or
The Figure.

and between each of these classes are many varieties. Luminosity and Colour are important with reference to both plain and figured cloths. Sometimes light cloths are in favour, sometimes dark cloths; sometimes figures in analogous luminosities are in demand, sometimes strongly contrasting luminosities.

Similarly with colours: Sometimes analogous colourings are in fashion, sometimes violently contrasting colours, sometimes large surface effects in subdued colours and sometimes small surface figures in strongly contrasting luminosities and colours dominate. The colours may be any one of the following:—

Red, Orange, Yellow, Green, Blue, Violet, Buff, etc.

Fancy Designing.

Decoration involves a knowledge of the selection and use of natural and geometrical forms for the production of pattern and of effective Colour Combinations, which can only be satisfactorily obtained through a training in drawing followed by practice in design and the study of the best examples of ancient and modern fabrics.

The design of any object or material must be influenced in the first place by purpose and use; second, material, third, productive process. In the textile trade the type and use for which the cloth is required, its quality and composition and the particular weave and machine to be used in its manufacture have all to be considered.

Varieties for Utility.

There are different kinds of demands among cloth users, and these demands determine what fabrics shall be manufactured and sold. The strongest and most constant cloth demand of people in general is for enduring materials that have proved themselves to be the best and most adaptable fabrics for the common needs of daily life.

Varieties Demanded By-Fashion.

Another strong demand that determines what new fabrics shall appear is the style demand.

This constant changing of the kinds of cloth favoured by fashion has much influence upon the prices of materials.

Varieties for Specific Purposes.

There are certain specific demands that add their bit toward swelling the great variety of kinds of cloth produced. The weaving of cloth labels, banners, all kinds of insignia, illustrates a part of the highest endeavours of artistic construction.

New demands for textile fabrics are constantly arising in civil life. One very important and constant demand is for cotton cord in automobile tires. With the almost unprecedented growth in the use of motor vehicles both for pleasure and for practical purposes has come a demand for tire that will live under the strain of speed and weight. The world of cloth has combined with the world of rubber in the production of this much—needed article.

The Suitability of Yarns.

The suitability of the particular yarns of which the fabric is to be constructed are necessarily determined by the type of weave and the looms available. The decorative effect may be obtained by the use of a fibre of a particularly attractive quality, by the introduction of other material, the contrasting texture of which enhances the effect, or in elaborated weaves which give an interesting surface texture, by embossing a special finish, by the use of colour, either in dyed yarns or grey cloths dyed in the piece, or by colour printing.

The designer must have some knowledge of cloth structure and measurement, of the patterns suitable for different markets.

The weaver, the dyer and the printer must possess technical skill in their particular branch of industry, and they should be able to realise defects and weakneses in the texture or colouring of the material, so that faulty pieces are not produced.

Dobby Cloth.

Many of the simple fancy cloths woven in dobly looms have some sort of stripe, either of the same or different yarn and of the same or different weave, as compared with the body of the cloth.

Some of these cloths have extra warp stripes of figuring material, which shows on the face side where required and is taken to the back until it is required to show again. This figuring material floating on the back of the cloth is sometimes cut away, without injury to the body of the fabric.

The chief difficulty when weaving dobby cloth is to form a sufficiently clear shed for the passage of the shuttle. The large number of heald staves used makes the distance from the back shafts to the reed a ready source of trouble in causing slack threads. Also, when two or more weaves are used, the fact of all the yarn coming from one beam causes the ends with the least number of interlacements to hang slack.

Keep Back Rest Low.

In dobby work, the back rest has to be kept low, it is an advantage tohave the back rest extended backwards by longer brackets. The lower position of the back rest, combined with the greater length of yarn from the beam to the healds, when using a large number of heald staves, obviously helps to produce satisfactory weaving. Much can be done by a correct lease of the warp ends in the lease rods; and, if possible, the ends that hang slack should always be put under the front rods. Occasionally it may be necessary to use a third lease rod under which all the slack ends may be placed, the rod itself to be under the other warp ends, and to stand a little way in front of the usual front rod. If the stripe is in the form of a stitch, that is, any end lifting up for two or more picks and down for two or more, and the ground of the cloth plain weave; the ends should be drawn through healds at the front and not through the back staves, or it will be impossible to lift the ends to form a clear shed, where two different weaves are employed, one of them with a greater contraction of yarn than the other, less trouble will obviously be experienced if the warp are run on two beams.

Fancy Border Dhoties and Sarees.

In producing an effective and attractive Plain or Fancy borders Dhoties or Sarees attention must be paid to the following factors.

(1) Mixture or blending of various or different coloured threads.

(2) Dyed art silk is brighter than mercerised or cotton yarns.

(3) The jacks or shafts of dobbies employed for producing Fancy Borders vary from 8 to 40 in number.

(4) The hooks of Jacquard machine employed for Fancy Border Sarees vary from 100s to 400s for the production of variegated artistic and natural designs.

(5) The counts of cotton yarns employed for the purpose of Dhoties or Sarees borders are generally two-fold yarns such as 2/32s 2/40s, 2/50s, 2/60s, 2/80s and the counts of yarn for the body of the cloth vary from 20s to 100s for twist yarn and 30s to 120s for weft yarn. The counts of yarn most commonly used for producing figuring work are 2/42s and 2/60s.

(6) The counts of artificial silk are 2/150s denier art silk for the figures and for the body of the cloth the counts of cotton yarn vary from 40s to 100s twist and 50s to 120s weft and the counts of the art silk employed for the body of the cloth is generally of 100s (Dull).

(7) The denting for the figuring of the borders vary from 4 to 6 ends per dent. The denting depends on counts of yarns and reed used for a particular design.

CHAPTER XXXVIII.

ANALYSIS OF WEAVE.

The weave or design of a fabric is the method by which the warp threads or ends interweave with the weft threads or picks. A counting-glass having an inch square opening and a double achromatic is the best to use for practical purposes.

The design of a simple or plain weave, or twill, satin, sateen weave can be at once placed on the design paper Fig. 6 (8×8) but if a dobby design, the picks must be read off one by one. Cut down the sample and remove a few ends, also picks, then start at No. 1 end Fig. 5 and read off the interlacing of the weft pick with each end; follow this, pick by pick, till a repeat has started. Of course, be very careful that the same end is used as a starting-point from the top pick downwards, then the design on the paper must follow the same course.

Dobby patterns are generally woven up to 16 or 18 shafts, weave of more than this number are woven on Jacquard looms. It is necessary to put the design on the squared paper at once if the sample submitted is a very small one because on removing any ends or picks the pattern may be destroyed.

How to find the Design from cloth.

Place pattern on the table with weft running from left to right. With a needle pointer Fig. 5. pick out the weft threads one by one. First cut the cloth straight at left-hand side, and remove a few threads; then, using a strong glass, follow the weft from end to end till a repeat occurs. Mark a square on a squared paper, where a warp shows above a weft thread, remove each weft thread when the intersections have been put on the paper. Each filled—in square on the paper represents a warp thread lifted over a weft thread, Fig. 8 and each blank square represents a warp thread under a weft thread. The same warp thread must be used as the starting-point for each weft thread taken out.

Peg plans.

The order of lifting and lowering the harnesses is marked on point paper, and is known as the peg plan Fig. 12.

Point paper.

Point paper is specially prepared, being ruled out in small squares with large squares superimposed, so that each larger square is ruled seven times horizontally and seven times vertically, giving 64 squares to each larger square. This is known as 8 ×8 paper and is the ruling generally employed for dobby work. There are many other rulings such as 8 ×10, 8 ×6, etc., but these are used mainly for Jacquard work.

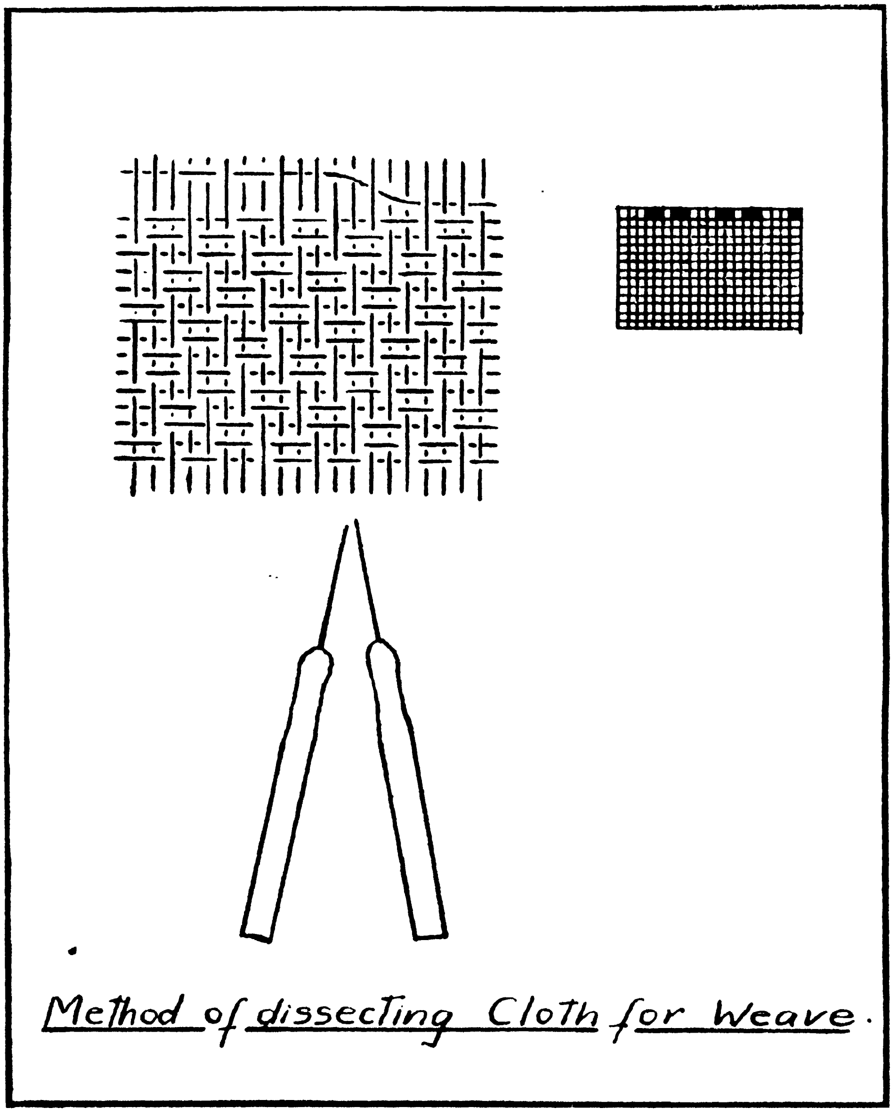


Fig. 5.

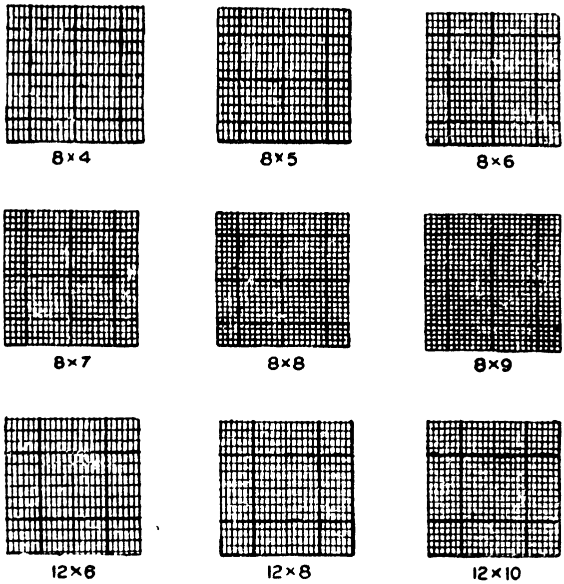
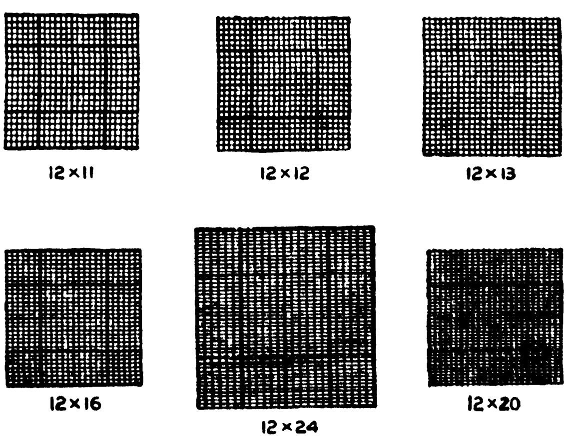


Fig. 6.



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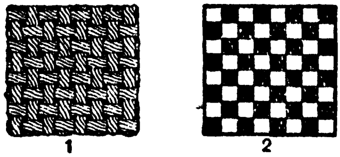


Fig. 8.

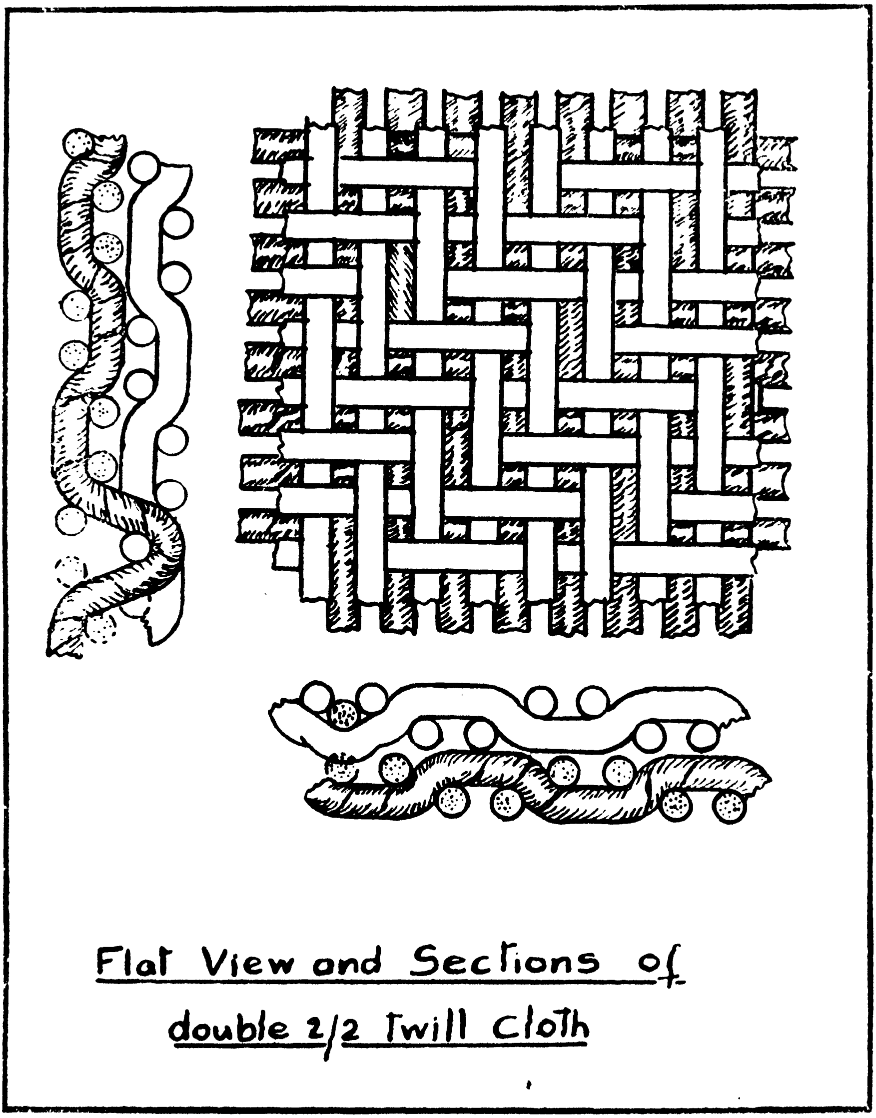


Fig. 9.

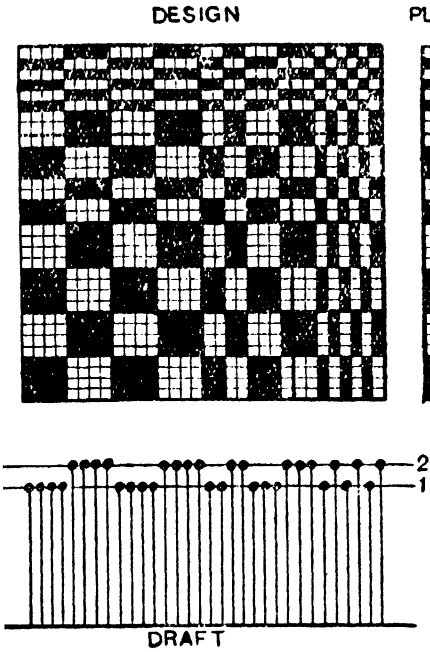


Fig. 10.

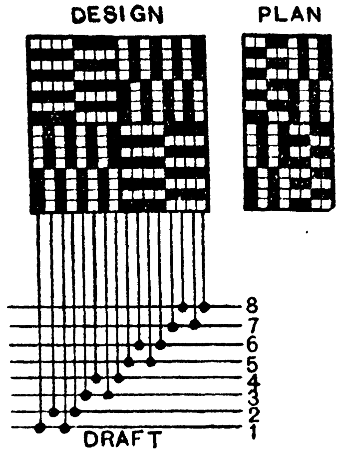
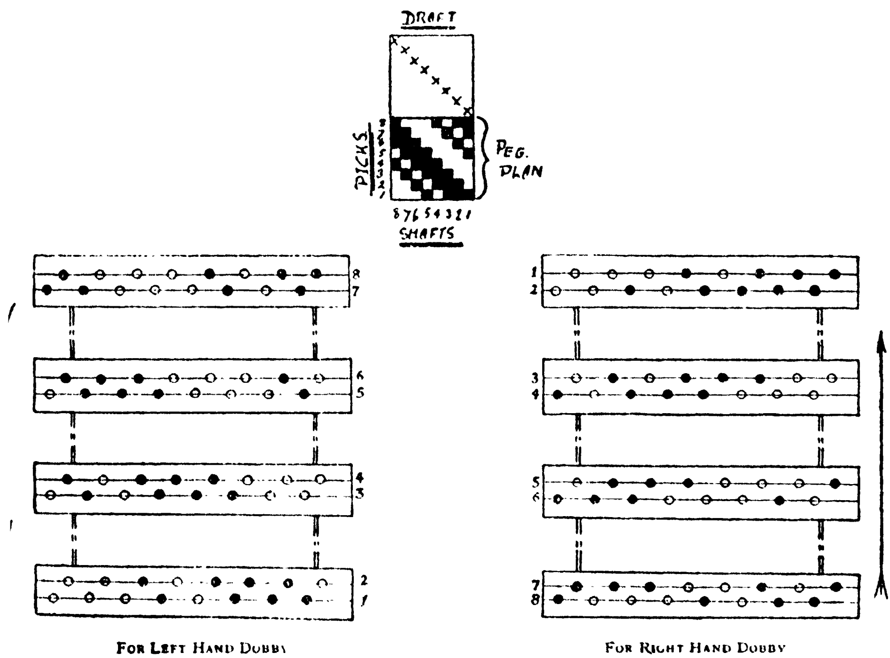


Fig. 11.



Laps turn in direction of arrows

Fig. 12.

Inserting and removing the pegs.

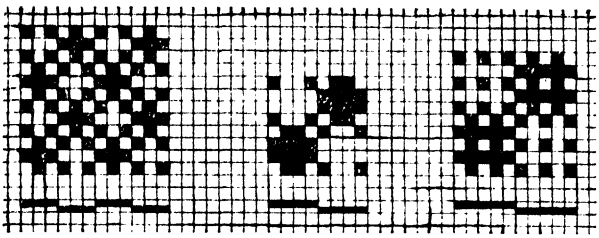
The pegs are made so that they will be a tight fit in the holes of the lags, and are usually slightly tapered. Care should be taken, when driving in the pegs, that they are not driven in too far, as this may result in splitting the lag. Even if no damage is done to the lag whilst pegging, the lag may split later when working in the dobby, causing the pegs to become slack in the holes and rendering them liable to drop out. At the same time, no peg should be at all slack in a hole. The distances the pegs stand out from the face of the lags should be as nearly equal as possible.

When pegging a set of lags, the first thing to determine is the first heald and the first pick, as indicated by the peg plan. It next becomes necessary to peg the pattern in such a manner that the lag containing the first pick will be placed on the cylinder first, while the pegs that control the first heald must come at front of the loom, so that the pegs will operate the first pair of jacks. In the construction of a peg plan, the first heald is always represented by the extreme left-hand vertical row, so that it would be safe to commence the pegging of the pattern anywhere, that is, on any pick, provided the peg plan was read from left to right. For the sake of convenience the pegging is begun at the botom left-hand corner. Before any peg can be inserted into the lags, it is essential that one should know whether the pattern is for a right-or left-hand dobby.

Right-and Left-hand Dobbies.

Dobbies are made both right—and left—hand, the cylinder of a right—hand dobby revolving clock-wise, whilst that of a left-hand dobby revolves anti—clockwise.

If a pattern is complete on less than eight lags it must be pegged twice. The pattern, or lag, barrel is made to take eight lags, and any number less than eight will therefore be inadequate. Say, for example, that a pattern is complete on six lags, then two complete repeats must be pegged, making twelve lags in all. Again, suppose a pattern repeats on an odd number of picks, then the pattern must be pegged twice, no matter how many lags it repeats upon. Each lag is made to take two picks, so it is obvious that the repeat must occupy all the picks on the lags in the lattice. In the case of an odd number, the pegging of two full repeats is the only remedy.



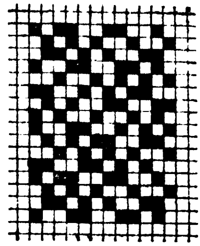


Fig. 13. Fig. 14. Fig. 15. Fig. 16.

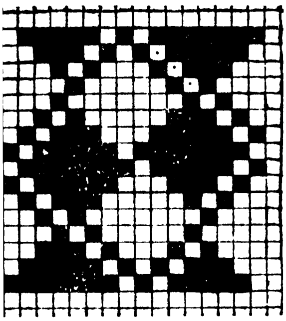


Fig. 17.

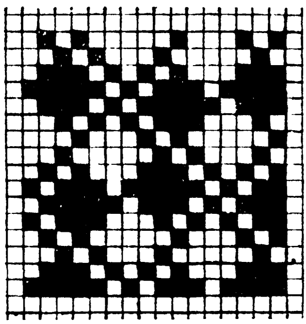


Fig. 18.

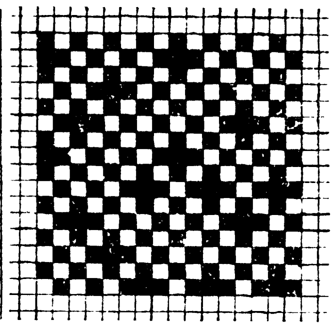
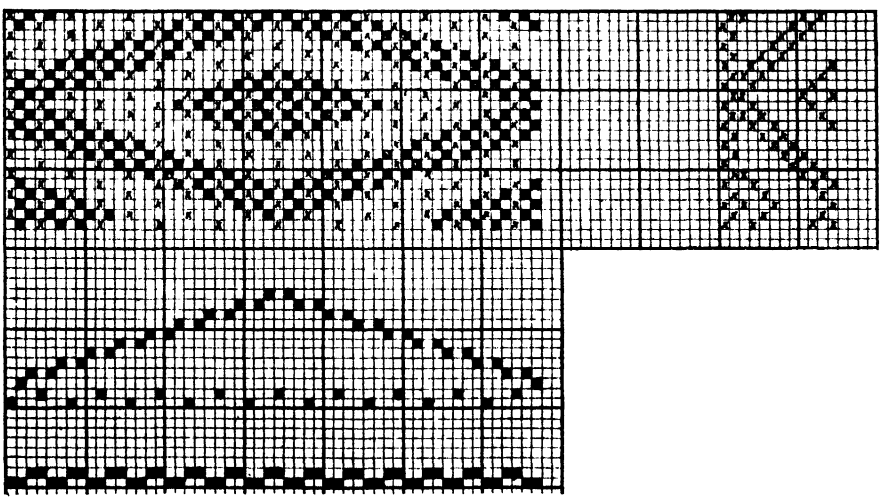


Fig. 19.



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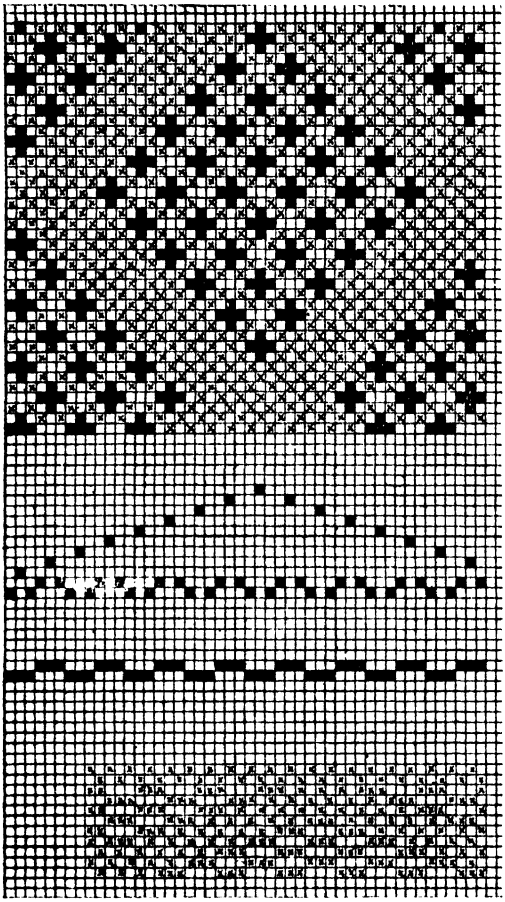


Fig. 21.

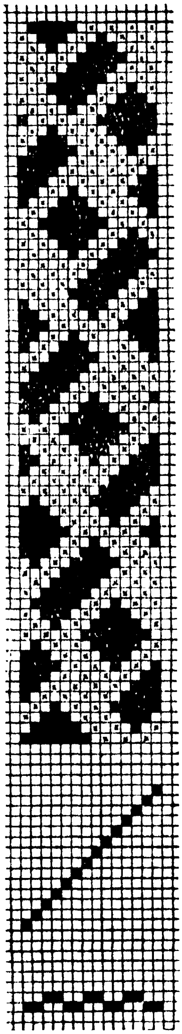


Fig. 22.

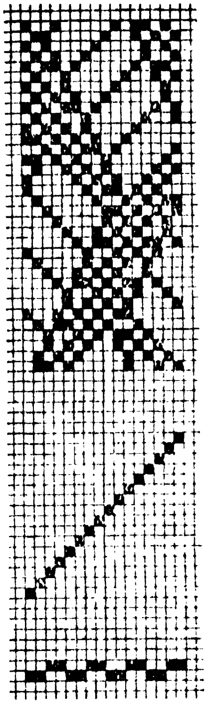


Fig. 23.

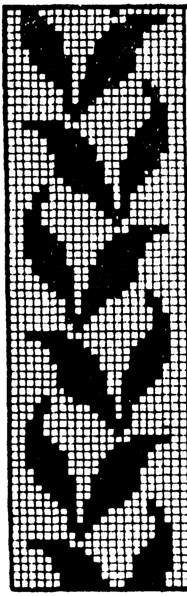


Fig. 24

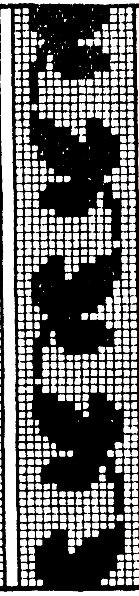
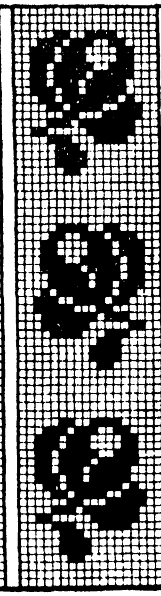


Fig. 25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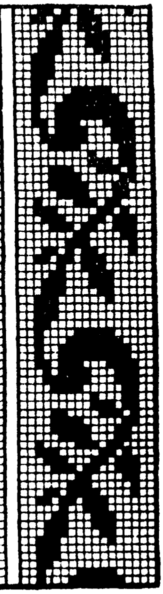
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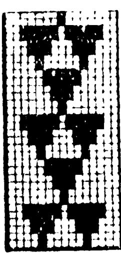
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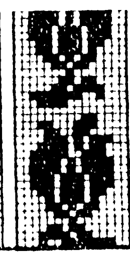
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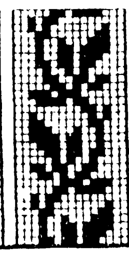
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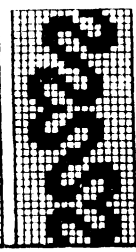
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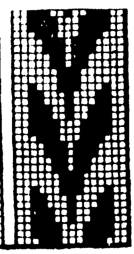
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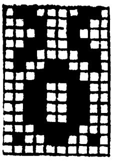

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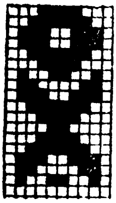

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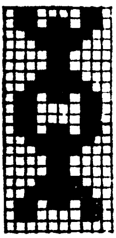

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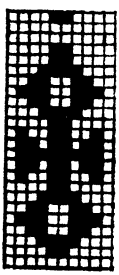

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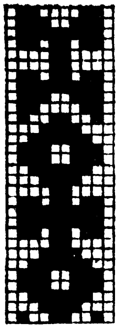

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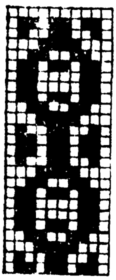

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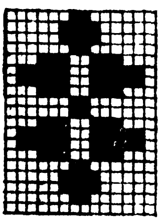

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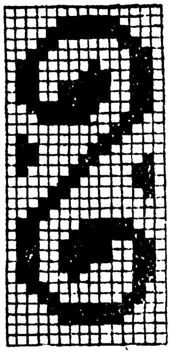

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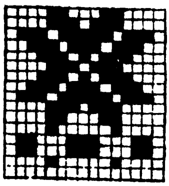

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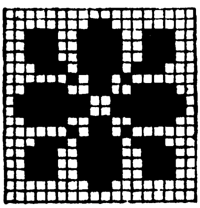

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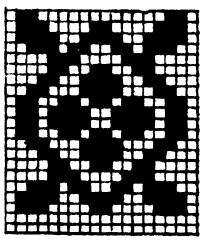

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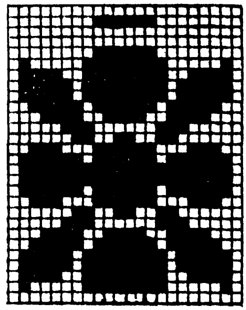

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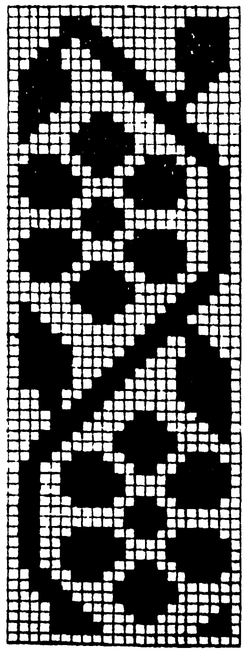

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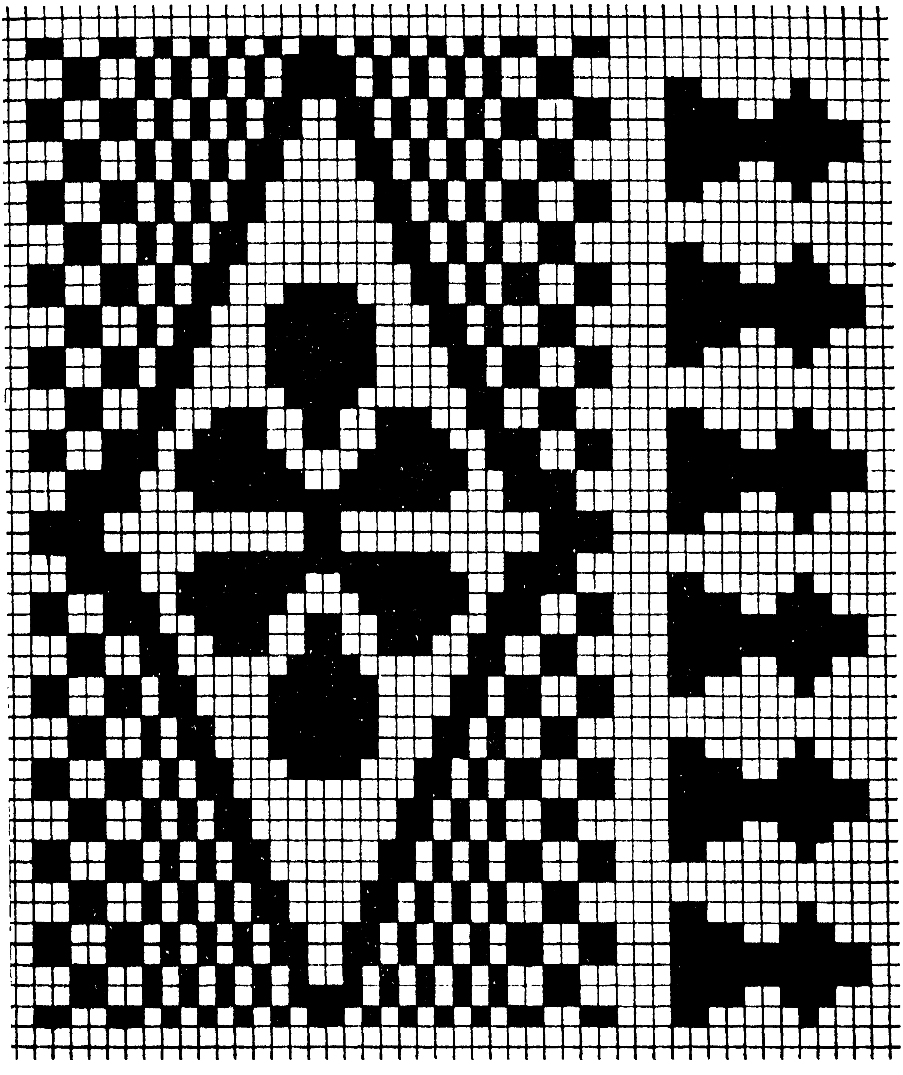

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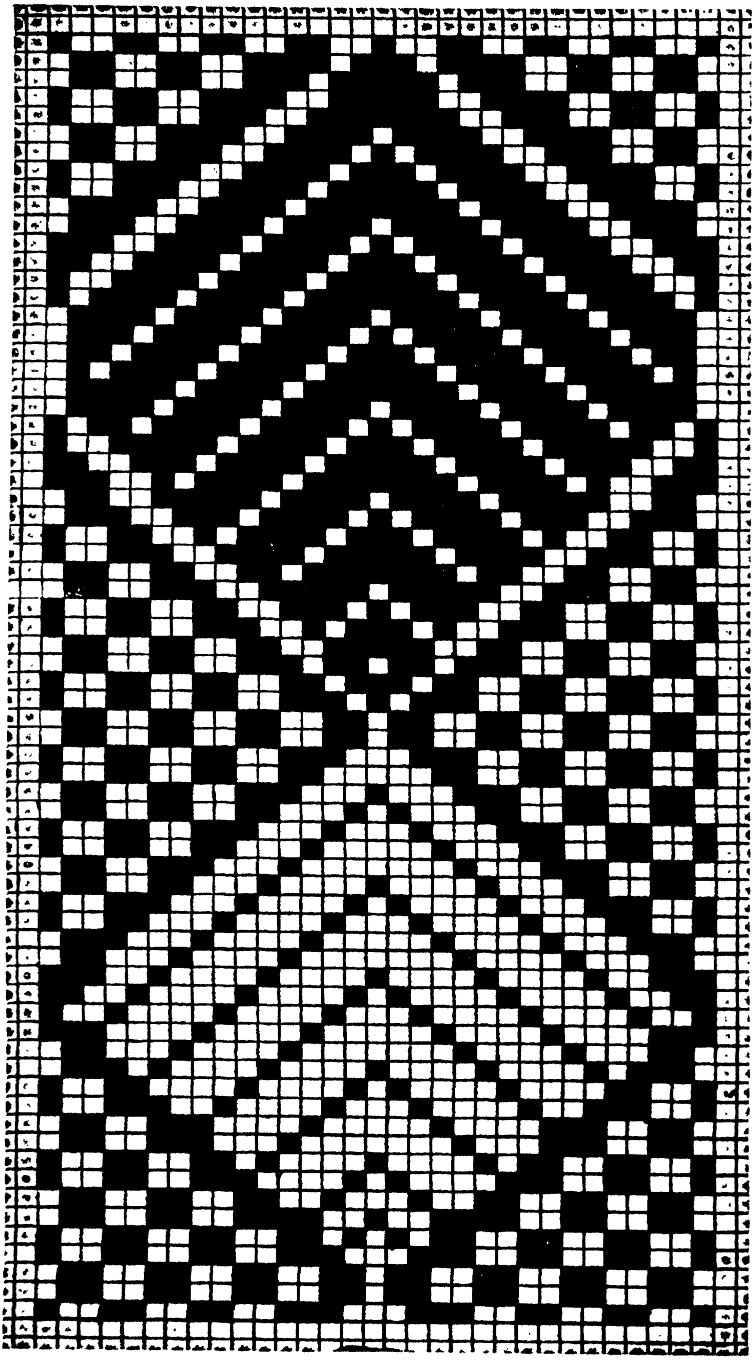

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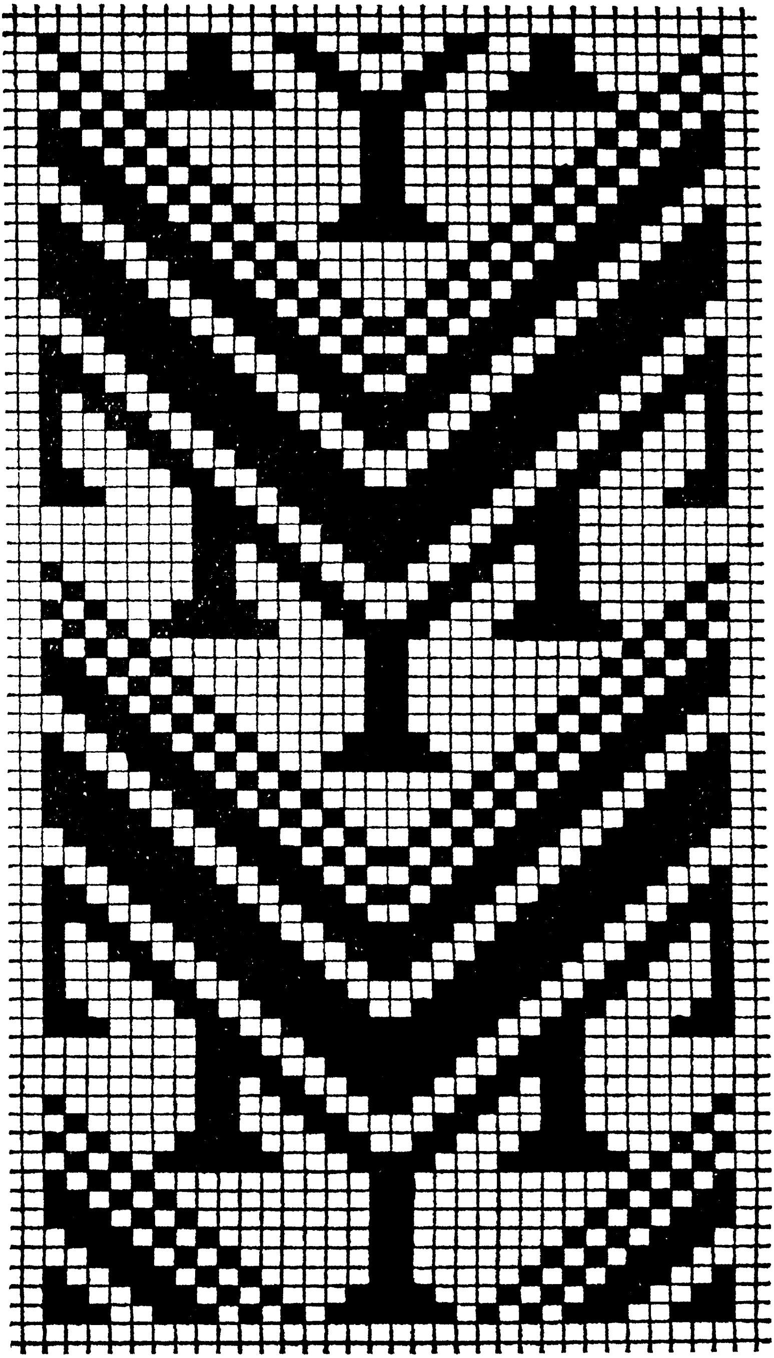

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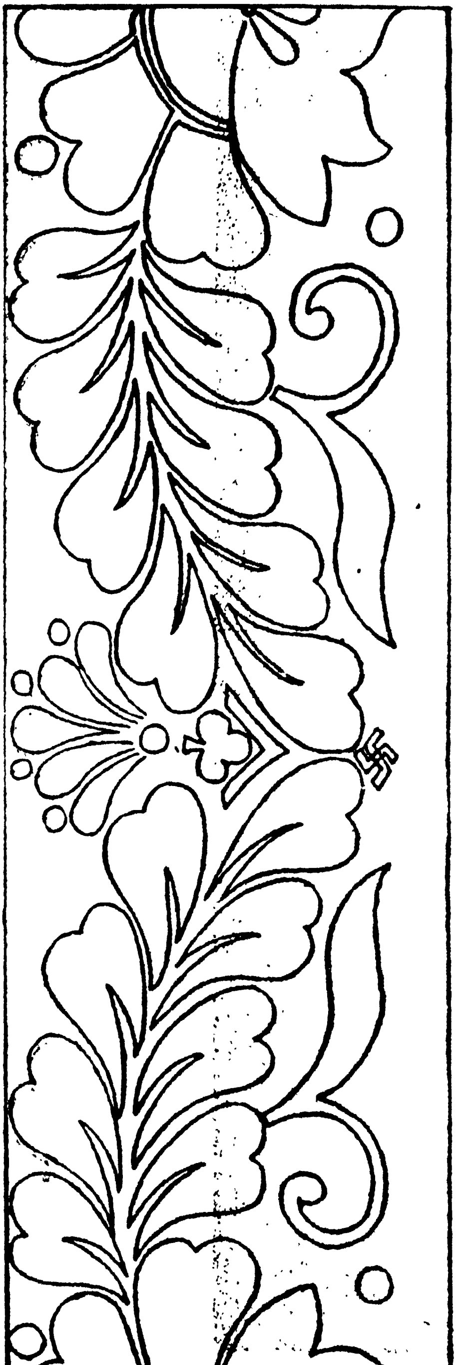

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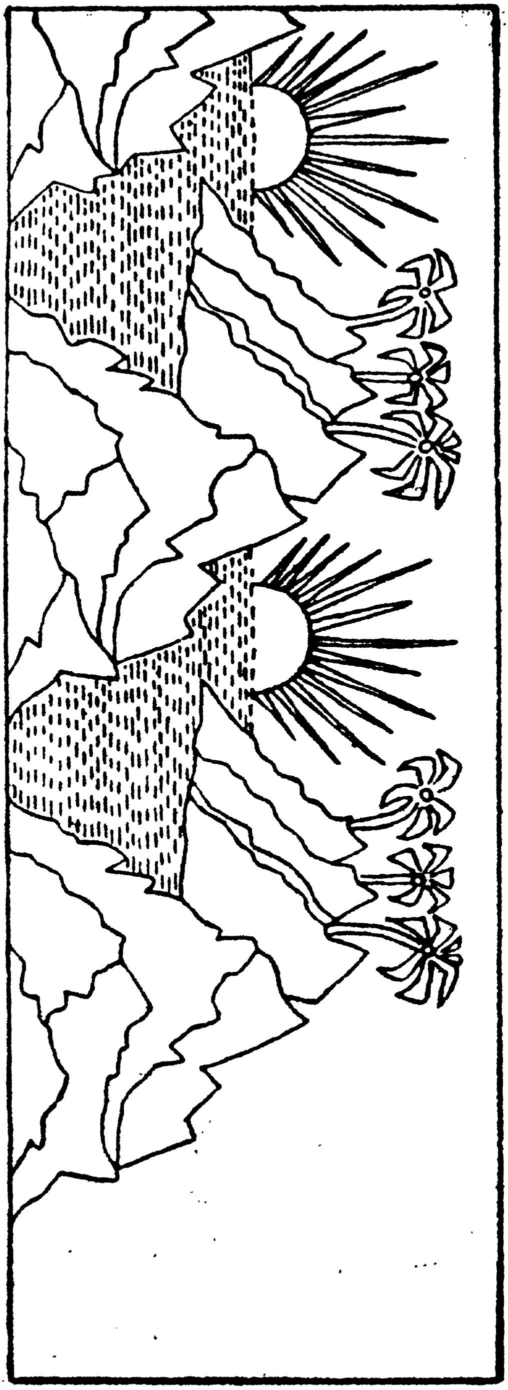

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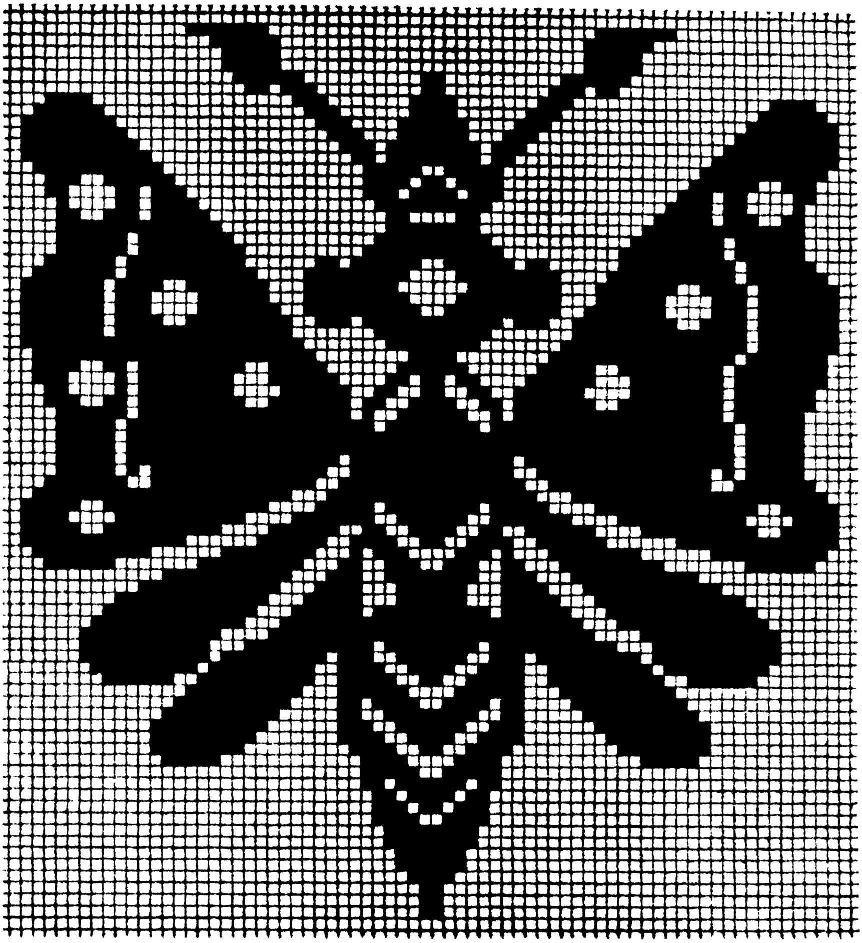

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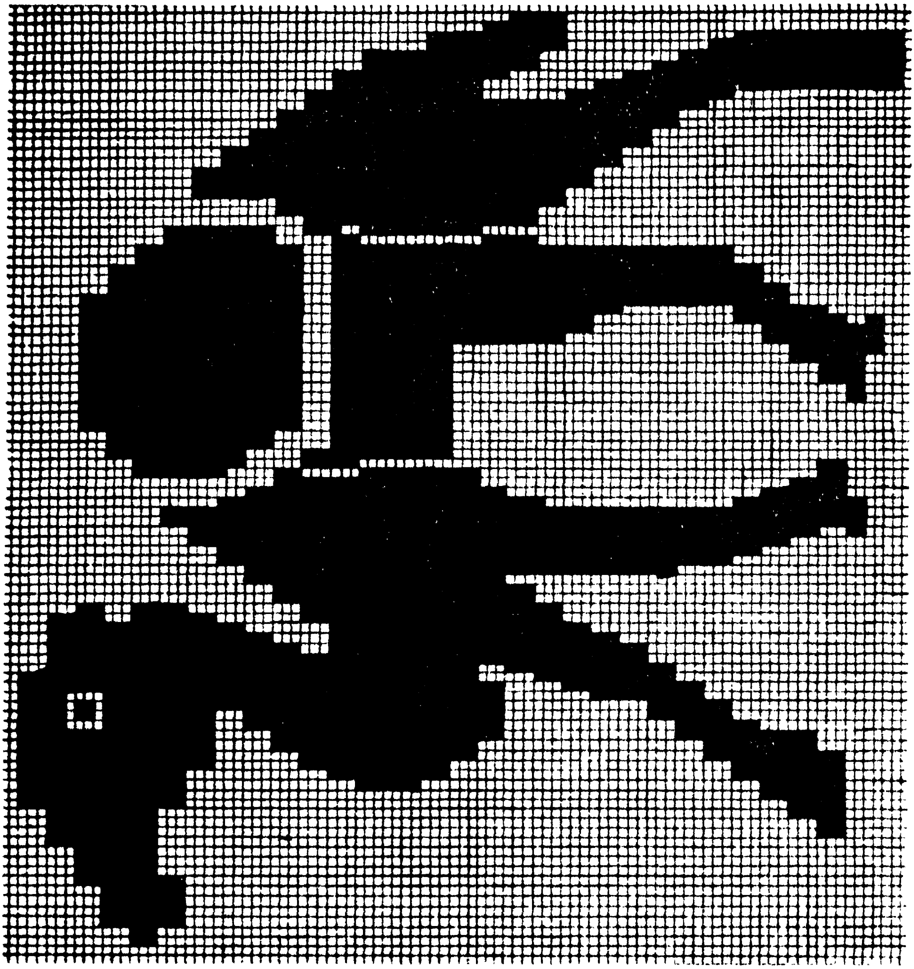

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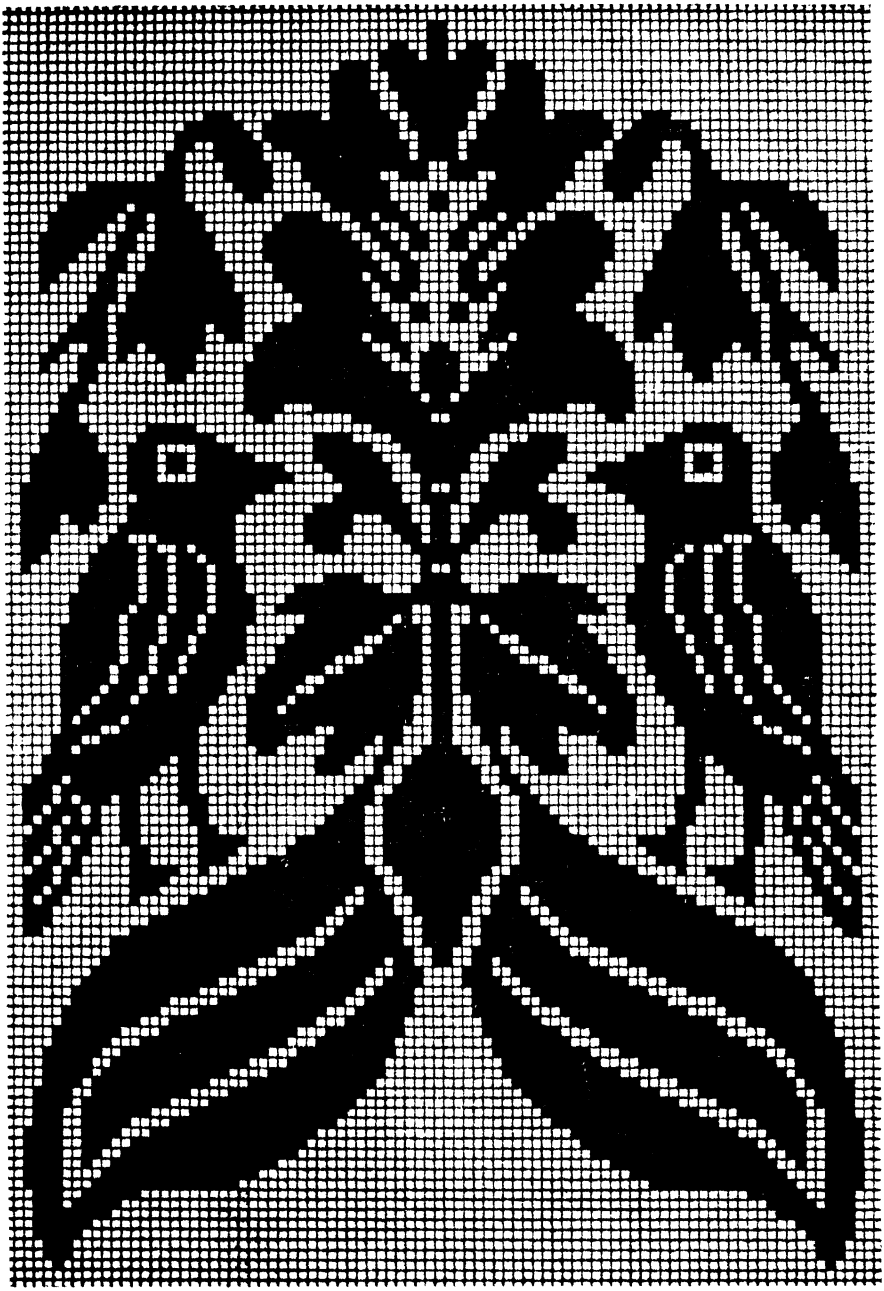

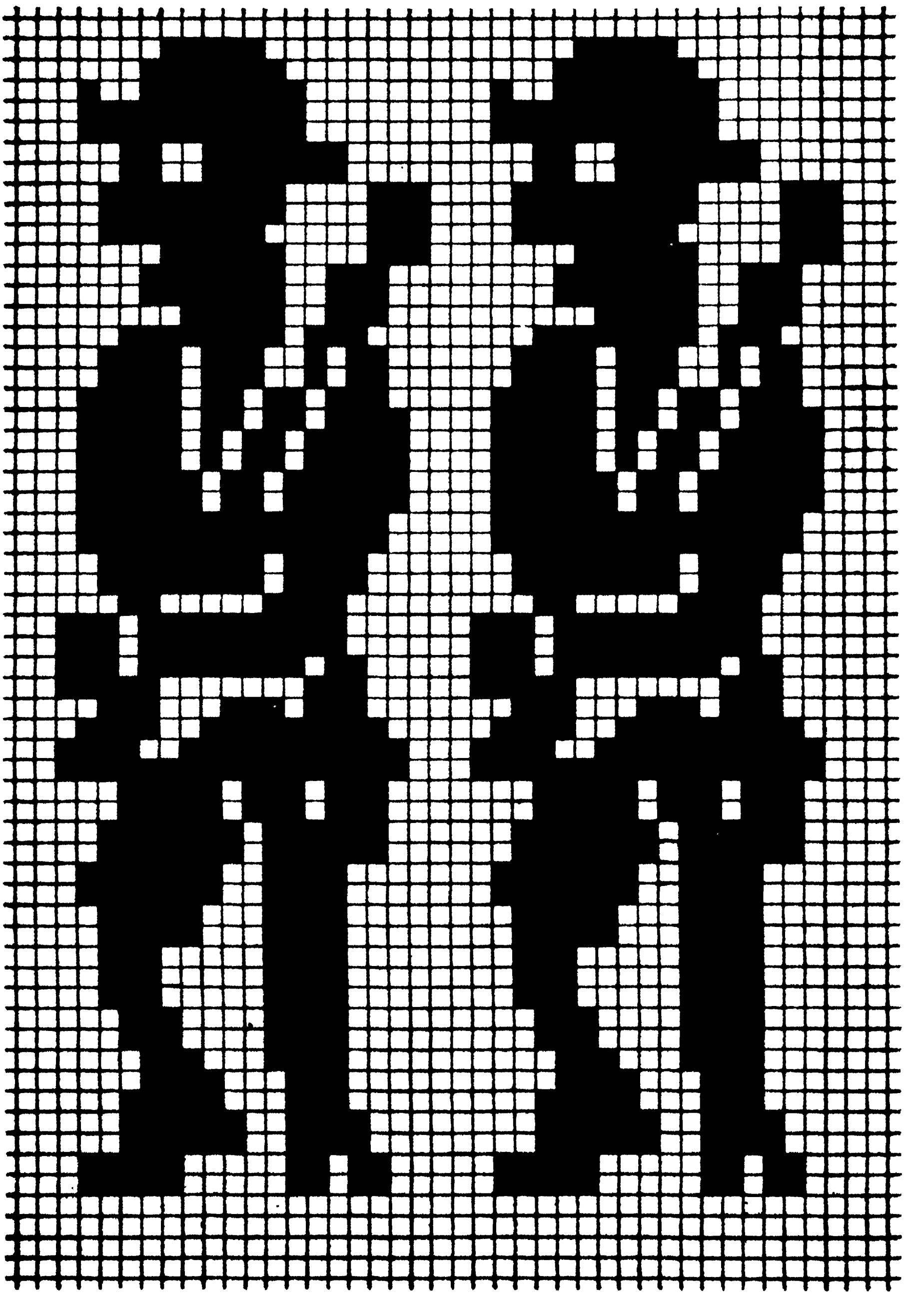

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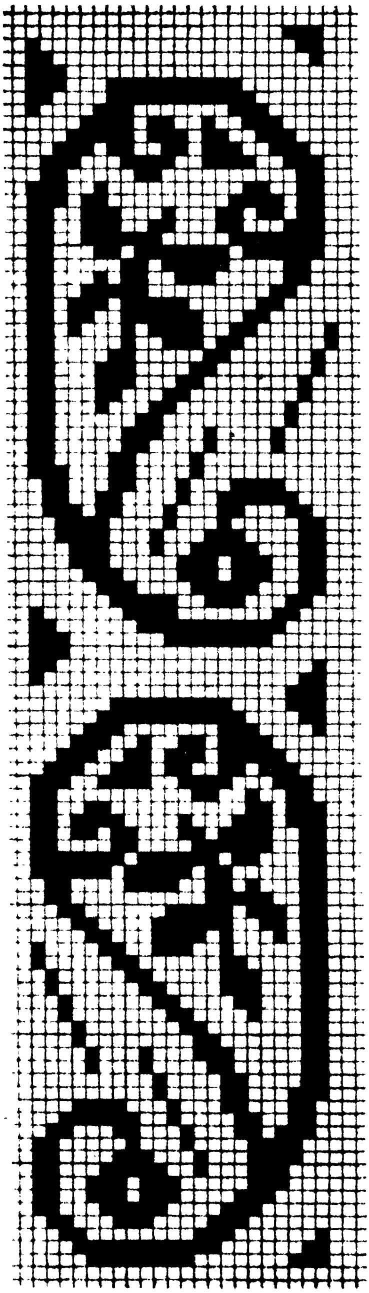

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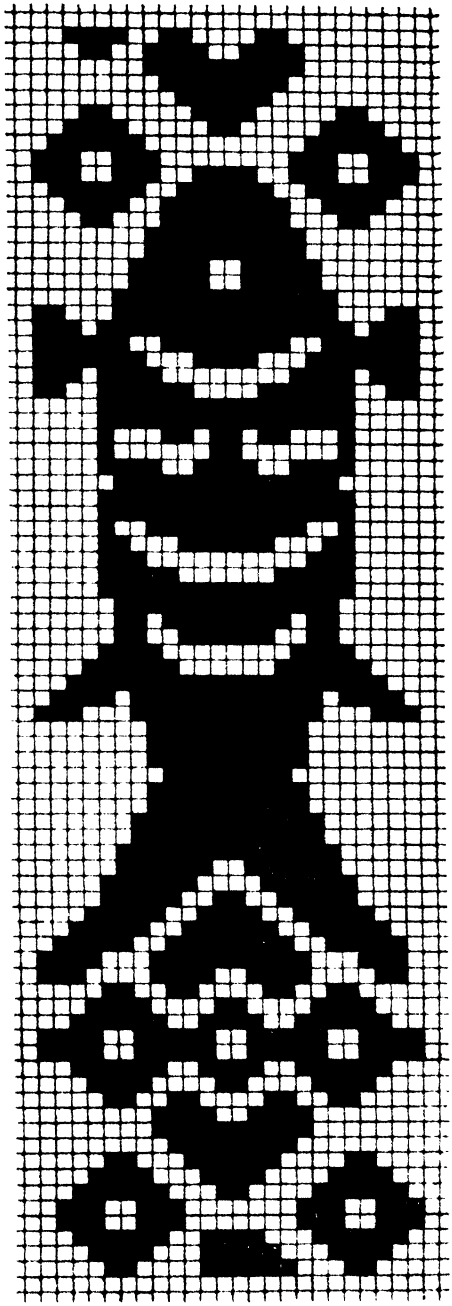

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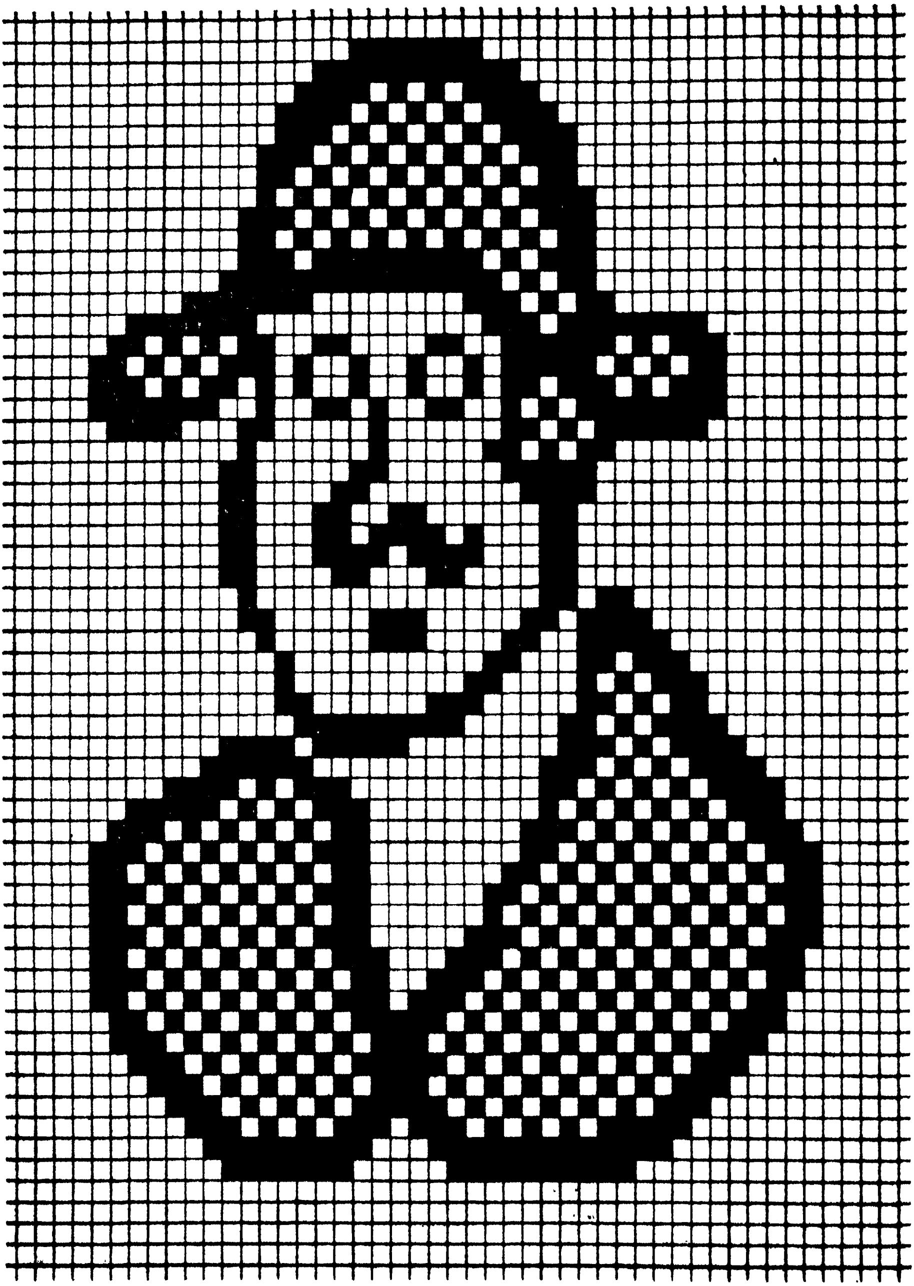

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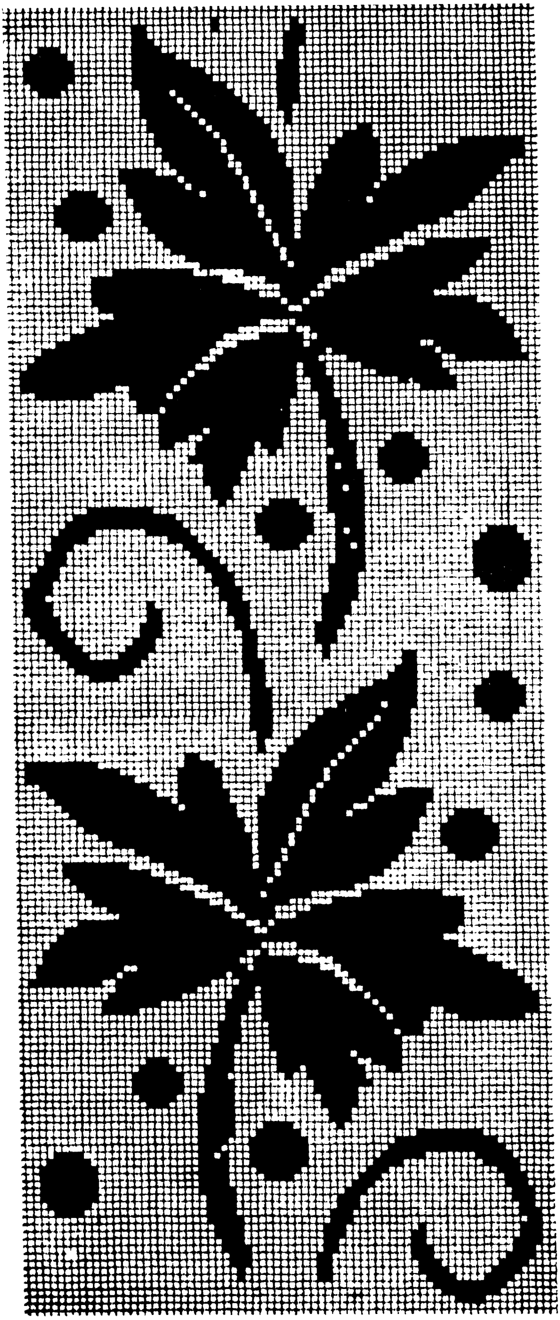

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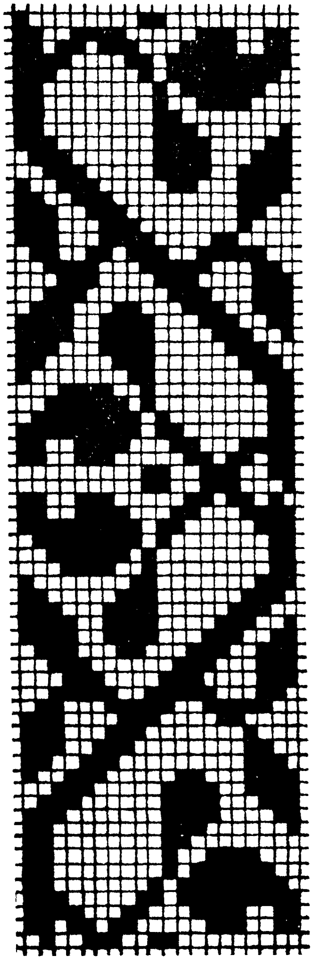

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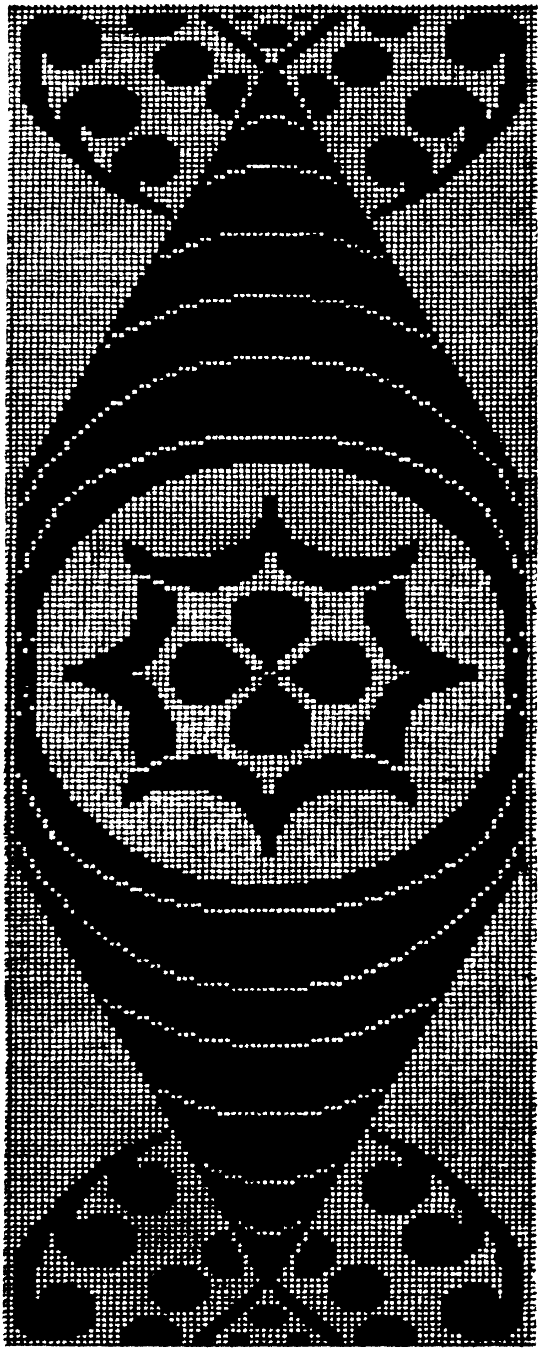

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DESIGNS FOR STRIPE SHIRTINGS.

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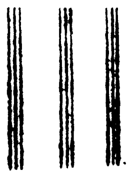

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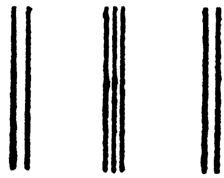

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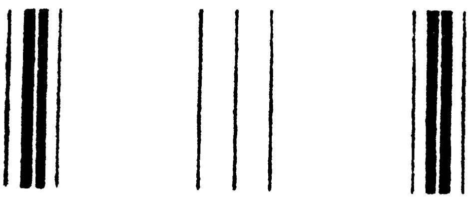

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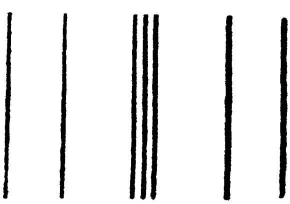

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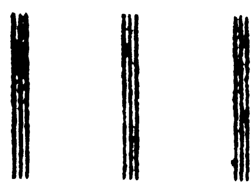

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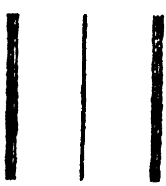

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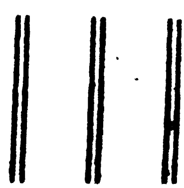

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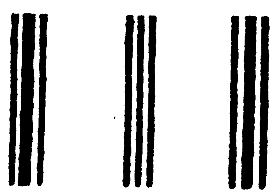

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CHAPTER XXXIX.

CLOTH MANUFACTURING PARTICULARS.

Ins.	Yds.	Per Inch. Reed.	Pick	Counts of Yarn. Warp.	Weft.	Reed Space	Tape. Length yds.	Remarks.
41/39	19¾/20	32	32	22	26	45½	20 1/9	Dyed Shirting
43½/41	19¾/20	32	34	22	26	47¾	20⅛	,, ,,
52½	24	32	34	9½ C&G	12 C G	55	25½	Khadi.
22	24	32	28	16 C&G	22/26 C G	24¾	24⅓	Susi check.
21	24	32	24	22	22/26	22¾	24	Gamcha (check).
46	2 1/9	36	16	16	2¼	51	2¼	Blanket for Raising.
64	5½	36	28	2/16	5	68	5 5/6	Fancy Bed Spread.
38	5	36	28	16	22/26	43½	5⅛	Loongi check cloth.
22	7	36	28	22	28	27	7	Pagri cloth (Bleached).
22	5	36	32	22	26	24¼	5⅛	⅝″ Dhoty (cal.)
32	22½	36	34	13	16	34½	23_9	Sheeting (uncalendered)
36	10	36	34	13	16	39	10⅛	N. B. Dhoty.
43	11	36	34	13	16	46½	11 2/3	N. B. Dhoty.
37	36	36	38	22	26	44	36 13/18	Red Dyed Madra Cloth.
24	24	36	38	16	22	29	24	Susi for Finishing.
42	20	36	38	22	26	49	20 5/9	Red Dyed Madra Cloth.
38	8	36	40	22	18	41½	8⅓	N B Dhoty (uncalendered)
38	5	40	28	16	22	43½	5-1/16	Loongi check cloth.
63	37½	40	38	16	20	66¼	39⅜	Long cloth (uncalendered)
40	10	40	38	22/2/40	26	43⅜	10 2/9	1½″ Three B. Saree.
44	10	40	38	22/2/40	26	47⅜	10 2/9	1½″ ,, ,, ,,
28	24	40	36	9½	12	29½	25	Khadi (calendered).
27	24	40	36	9½	12	27¾	26	Khadi (uncalendered).
40	24	40	36	10	12	41¼	26	Khadi (uncalendered).
36	10	40	36	22	18	39¼	42	Long cloth (calendered)
36	38	40	36	18	17	38¼	40	,, ,, (uncalendered)
37	38	40	37	22	26	41¼	39¼	Long cloth (calendered)

Ins.	Yds	Per Inch. Reed.	Pick.	Counts of Yarn. Warp.	Weft.	Reed Space.	Tape. Length	Remarks.
39	10	40	40	13	16	$42\frac{3}{4}$	$10\frac{1}{2}$	N. B. Dhoty.
36	$37\frac{1}{2}$	44	40	18	25	39	$38\frac{3}{4}$	Long cloth (calendered)
40	$37\frac{1}{2}$	44	40	16	20	43	$39\frac{1}{4}$	Long cloth (calendered)
42	$37\frac{1}{2}$	44	40	18	25	45	$38\frac{3}{4}$	Long cloth (calendered)
44	10	44	40	40	30	47	$10\frac{2}{9}$	$\frac{1}{8}$" Dhoty.
23	5	44	40	32	40	26	$5\frac{1}{6}$	$\frac{1}{8}$" Do.
31	8	44	40	32	40	$33\frac{3}{4}$	$8\frac{1}{8}$	$\frac{1}{8}$" Do.
35	9	44	40	32	40	$38\frac{1}{4}$	$9\frac{1}{4}$	$\frac{1}{8}$" Do.
42	10	44	40	22	22	$46\frac{1}{2}$	$10\frac{1}{3}$	$\frac{1}{8}$" Do.
44/40	5	44	40	40	50	47	$5\frac{1}{4}$	Dupata Bleached.
27	20	44	44	2/30	16	$30\frac{1}{2}$	20	Check coating (Finished).
39	10	44	48	32	26	$43\frac{1}{4}$	$10\frac{1}{3}$	2" Saree.
48	10	46	46	22/2/40	20	$57\frac{1}{2}$	$10\frac{1}{9}$	$\frac{1}{4}$" Dhoty (for Bleaching)
32	38	48	32	14	16	$31\frac{1}{2}$	40	Khadi cloth.
44	10	48	36	40	30	47	$10\frac{2}{9}$	$\frac{1}{8}$" Dhoty (calendered)
38	38	48	40	22	24	$40\frac{1}{2}$	$39\frac{5}{8}$	Markin.
35	9	48	40	22	26	$37\frac{3}{4}$	$9\frac{1}{3}$	$\frac{1}{2}$" Dhoty.
27	6	48	40	22	26	$30\frac{1}{4}$	$6\frac{1}{9}$	$\frac{1}{2}$" Do.
30	24	48	48	22	26	37	$24\frac{1}{2}$	Stripe Shirting (Bleaching)
44	10	48	48	40	40	47	$10\frac{2}{9}$	$\frac{1}{8}$" Dhoty
44	10	48	48	40	60	47	$10\frac{2}{9}$	$\frac{1}{8}$" Do.
44	10	48	48	22/2/40	20	$47\frac{1}{2}$	$10\frac{5}{9}$	2" Saree.
50	$37\frac{1}{2}$	48	48	22	24	54	$39\frac{1}{2}$	L. Cloth.
50	$5\frac{1}{2}$	48	48	16	18	$53\frac{1}{2}$	$5\frac{8}{9}$	Chaddar.
40	40	48	52	50	40	44	41	Grey Mul Mul.
54	18	52	44	20	30	62	$18\frac{1}{2}$	China Cord.

Cloth Manufacturing Particulars.

Ins.	Yds.	Per Inch. Reed.	Pick.	Counts of yarn. Warp.	Weft.	Read Space	Tape Length	Remarks
44	5	52	44	50	50	48	5⅛	2½" Saree.
27	40	52	48	22	26	31¾	40	Twill Khaki.
44	10	52	48	40	30	47¼	10 4/9	⅛" Dhoty.
44	10	52	52	40	40	47	10¼	⅛" Do.
44	10	52	52	40	60	47¼	10 2/9	⅛" Dhoty.
38	24	52	52	16	18	40¼	26¼	Seetan (uncalendered).
44	10	52	52	32	50	48	10	¼" Dhoty.
47	20	52	56	40	50	49½	20 11/18	Mul Mul.
44	38	56	48	20	30	46½	39½	Shirting (calendered).
40	66	56	52	16	18	42½	71½	Domestic (uncalendered).
44	10	56	52	32	40	47¼	10⅛	⅛" Dhoty.
44	10	56	56	40	40	47	10½	2" Saree.
44	10	56	56	40	40	47	10/29	⅛" Dhoty.
44	5	56	56	50	40	47	5⅛	2" Saree.
35/32	40	56	56	22	18	37	41	Twill Shirting (Bleaching)
44	10	56	56	50	70	47	10/29	⅛" Dhoty.
11/9	20	56	56	40	50	13	20½	Pagri cloth (Bleaching).
47	9	60	56	20	30	53.8	9¼	¼" Dhoty.
33/30	10	60	60	32	40	35	41⅓	Shirting (Dyed)
30	40	3/44	44	14	14	31	43¾	Plain Drill.
44	10	72	72	80	100	47	10/29	⅛" Dhoty.
29	20	3/48	46	12	16	30¾	21⅛	Plain Drill.
29½/24	2/72"	4/36	36	18	8	31½	2½	Honey Comb Towel.
29	40	3/52	54	18	8	31½	44¼	Plain Drill
56	86"	24	15	12	1.15 cashmere	58.36	2 17/18	Blanket.
45	4	22	14	14	1.55 grey.	48½	4/49	Blanket.
52	84"	28	32	2/14s Tinted	1.65 col.	57½	87"	Durrey.

CHAPTER XL.

TABLES.

Cotton Yarn Measure.

120 yards	=1 skein		
7 skeins	=1 hank		
18 hanks	=1 spindle		
54 in.	=1 thread		
4,300 in.	=80 threads	=1 lea or rap	
30,240 in.	=560 threads	=7 leas	=1 hank
1 hank	=840 yards	=768 metres	
20 hanks	=1 doffing		
1 spindle	=18 hanks or 15,120 yards =13,824 metres.		

Linen Yarn Measure.

300 yards	=1 cut	
2 cuts	=1 heer	
6 heers	=1 hank	
4 hanks	=1 spindle	=14,400 yards
90 in.	=1 thread	
10,800 in.	=120 threads	=1 lea or rap
108,000 in.	=1,200 threads	=10 leas =1 slip
2,160,000 in.	=24,000 threads =200 leas =20 slips =1 bundle	

Ermland yarn is 85½ in. to 1 thread and 40 threads to 1 lea.
Hamburg yarn is 80 in. to 1 thread and 90 threads to 1 lea.

Worsted Yarn Measure.

36 in.	=1 thread	
2,880 in.	=80 threads	=1 lea or rap
20,160 in.	=560 threads	=1 hank or 560 yards
7 raps		=1 hank

The Reel

The cotton reel is 54 in. in circuit.
The linen reel is 90 in. in circuit.
The worsted is 30 in. in circuit.

The ounce thread reel is 30 in. in circuit, and a hank of this yarn is 30 yards.

Silk Yarn Measure.

1 reel =1½ yards or 1.217 metres.
1 hank =3,328 yards or 3,043 metres.

Artificial Silk.

To convert English cotton counts into Deniers, divide 5314.9 by number of cotton counts = Deniers.

Italian Denier system, and London Conditioning House weight of 520 yards in deniers = Counts.

∴ if 520 yards weighs 90 deniers = 90^s den. yarn.

33.33	den.	=1 dr. (avoir).
533.33	,,	=1 oz.
8533.33	,,	=1 lb.

Metric Denier

Weight of 9000 m. in grm. = Counts.
9000 m. weighs 120 grm. = 120 den. yarn.

1 Metre	=39.37011 inches = 1.094 yards.
1 yard	=0.9144 metres.
1 kilogram	=2.2046 lbs. or 2.20 lbs. practically.
1 lb.	=453.593 grammes = 0.4536 kilogramme.
1 gramme	=15.432 grains.
7000 grains	=1 lb.

By calculating the metric equivalents, a conversion dividend is found. The denier or counts is divided into 5315 (practically), used as a constant. In similar manner constants for other yarns may be ascertained.

Ramie yarn.—The hank is 1000 metres. The count is the number of hanks in 1 Kilogram.

Raw Silk.—Dram System—The hank is 1000 yards and the number of drams that such a hank weighs is the count of yarn.

Spun Silk. is reckoned on the same basis as cotton in all single yarn, but in folded yarns the number of threads in the folded yarn is written after the actual count of the resultant yarn. Thus 210/2 means that the yarn is actually 210ˢ counts and is composed of two threads of finer counts.

Union yarns.—Cotton and wool—The count is the number of hanks of 840 yards, each contained in 1 lb.

Linen yarn—Wet Spun—The hank or lea is 300 yards, and the number of these in 1 lb. is the count of the yarn. A spindle is 48 leas = 14400 yards. A bundle is 200 leas = 60,000 yards.

Linen yarn—Dry Spun—The lea is 300 yards, 12 leas make 1 Irish or Scotch hank, and 4 hanks (48 leas) = 14,400 yards = 1 Spindle. The weight in lbs of 1 Spindle (14400 yards) is the count. Thus if 14,400 yards weigh 10 lbs., the grist or count of the yarn is 10ˢ.

Jute and Heavy Flax yarns.—are reckoned on the same basis as given for dry spun linen.

Hemp yarn—Fine hemp is reckoned on the same basis as linen (wet-spun), but coarser hemp, which constitutes the majority, is spun on the same system as jute.

Yarn Tables.

Weights.

24 grains = 1 dwt. (Troy)
18 dwts 5½ grs. or 437½ grains = 1 oz. (Avoir)
16 ozs. or 7000 grains = 1 lb.

Lengths.

1½ yards = Cir. of wrap reel.
120 yards = 1 Lea.
7 Leas or 840 yards = 1 Hank.

The number of hanks in one pound weight of any yarn gives the count. The weight used is 16 ozs. 840 yards of 1ˢ equals one pound.

Thus, 20 × 840 = 16800 yards in 1 lb. = 20s counts.

In folded cotton yarns the number of threads twisted together is indicated along with the count of the original singles.

Thus, 2/40s means that two threads of 40s are twisted together, and the resultant is 20s.

Very coarse cotton yarn below 1s is called bump yarn, and the counts are reckoned by the number of yards contained in 1 oz. (avoirdupois).

Continental System.

The hank is 1000 metres (1093 yards), and the number of hanks in ½ Kilogram is the count.

International System.

The hank is 1000 metres, and the number of hanks in 1 Kilogram is the count.

WRAPPING YARNS.

Wrap 120 yards (1 lea), divide the weight in grains into 1000.

Example ;—120 yards of yarn weighs 50 grains; what is the count

$1000 \div 50 = 20$s Counts.

The number of Hanks in 1 Lb. is the count of cotton yarn.

A bundle of cotton yarn is as many hanks as make 10 Lbs. in weight.

The number by which sewing cotton threads are sold represent three threads of the count twisted together—that is, No. 60's standard thread has 3 strands of No. 60's yarn in it.

In a six-cord thread each of the three strands is made up of two threads twisted together.

Six threads of No. 120s make six cord 12s.

The count is estimated both from long lengths of yarn and also short lengths of yarn. The former is obtained in lea or hank form and is the most common way of estimation by the spinners and weavers, and the latter is obtained from small or short Samples.

	Length unit	Weight unit.	Factor.
Cotton Bump	1 yd.	1 oz.	16
Spun Silk	Hank 840 yards.	1 lb.	840
Hemp Fine.	Lea 300yards.	1 lb.	300

Rule ;—

For conversion from one system to another—

$$\frac{\text{counts in known system} \times \text{factor}}{\text{factor in required system}} = \text{required count.}$$

Example ;—

Convert 60's worsted to cotton counts

$$\frac{60 \times 560}{840} = 40\text{'s cotton}$$

French counts of yarn $\times 1.18 =$ English counts of yarn

English „ „ $\times .847 =$ French „ „

TABLE FOR NUMBERING.

No. of Count.	Weight in Grains.	No. of Count.	Weight in Grains.	No. of Count.	Weight in Grains.	No. of Counts	Weight in Grains.	No. of Count.	Weight in Grains	No. of Count.	Weight in Grains.
5	1400	24	291.7	43	162.8	62	112.9	81	86.4	100	70
6	1166.6	25	280	44	159.1	63	111.1	82	85.4	105	66.7
7	1000	26	269.2	45	155.6	64	109.4	83	84.3	110	63.6
8	875	27	259.3	46	152.2	65	107.7	84	83.3	115	60.9
9	777.8	28	250	47	148.9	66	106.1	85	82.4	120	58.3
10	700	29	241.4	48	145.8	67	104.5	86	81.4	125	56
11	636.4	30	233.3	49	142.9	68	102.9	87	80.4	130	53.8
12	583.3	31	225.8	50	140	69	101.4	88	79.6	135	51.8
13	538.5	32	218.8	51	137.3	70	100	89	78.6	140	50
14	500	33	212.1	52	134.6	71	98.6	90	77.8	145	48.3
15	466.7	34	205.9	53	132.1	72	97.2	91	76.9	150	46.7
16	437.5	35	200	54	129.6	73	95.9	92	76.1	155	45.2
17	411.8	36	194.4	55	127.3	74	94.6	93	75.3	160	43.8
18	388.9	37	189.2	56	125	75	93.3	94	74.5	165	42.4
19	368.4	38	184.2	57	122.8	76	92.1	95	73.7	170	41.2
20	350	39	179.5	58	120.7	77	90.9	96	72.9	175	40
21	333.3	40	175	59	118.6	78	89.7	97	72.2	180	38.9
22	318.2	41	170.7	60	116.7	79	88.6	98	71.4	190	36.8
23	304.3	42	166.7	61	114.8	80	87.5	99	70.7	200	35

To find Cotton Counts—Reel 840 yards = one hank. Weigh this, and against its weight of grains in the table will be found its number or count.

To find Linen Counts—Reel 300 yards = one lea. Weigh it, and against its weight of grains in the table will be found its number or count.

To find Worsted Counts—Reel 560 yards = one skein. Weigh it, and against its weight of grains in the table will be found its number or count.

7000 ÷ Counts = Weight.

Table Showing Approximately the Strength of Yarn.

The weight that one Lea will bear before breaking, stated in pounds and ounces :—

	Ordinary Quality.		Fair Quality.		Good Quality.		Extra Quality.		Sup. extra Quality.	
No. of Yarn.	Breaking Weight.		Breaking Weight.		Breaking Weight.		Breaking Weight.		Breaking Weight.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
10	115	10	120	8	125	6	130	4	135	3
11	102	4	104	7	106	10	108	14	111	2
12	96	15	99	2	100	5	103	8	105	12
13	91	14	93	15	96	0	98	2	100	4
14	89	12	91	12	93	13	95	14	97	15
15	83	12	85	10	87	8	89	7	91	6
16	81	11	83	8	85	6	87	4	89	2
17	76	14	78	10	80	6	82	2	83	14
18	72	10	74	4	75	14	77	8	79	3
20	67	14	69	6	70	14	72	7	74	0
22	61	11	63	1	64	7	65	14	67	5
24	58	10	59	15	61	4	62	9	63	15
26	54	10	55	13	57	1	58	5	59	9
28	50	4	51	6	52	8	53	10	54	13
30	48	11	49	12	50	13	51	14	53	0
32	45	9	46	7	47	5	48	3	49	2
34	44	6	45	6	46	6	47	6	48	6
36	41	14	42	13	43	12	44	11	45	11
38	39	11	40	9	41	7	42	6	43	5
40	38	15	39	13	40	11	41	9	42	8
42	37	13	38	10	39	8	40	6	41	44
44	35	7	36	3	37	0	37	13	38	10
46	33	13	34	9	35	5	36	1	36	14
48	32	3	32	14	34	9	34	5	35	1
50	32	2	32	13	33	8	34	4	35	0
55	30	8	31	3	31	14	32	9	33	5

BREAKING STRENGTH OF YARN.—Contd.

Ordinary Quality.			Fair Quality.		Good Quality.		Extra Quality.		Sup. extra Quality.	
No. of Yarn.	Breaking Weight.		Breaking Weight.		Breaking Weight.		Breaking Weight.		Breaking Weight.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb,	oz.	lb.	oz.
60	27	10	28	4	28	14	29	8	30	2
65	25	8	26	1	26	10	27	3	27	13
70	24	6	24	15	25	8	26	1	26	10
75	22	12	23	4	23	12	24	4	24	13
80	22	0	22	8	23	0	23	18	24	0
85	20	4	20	13	21	6	21	15	22	8
90	19	8	19	3	19	14	20	9	21	5
95	18	8	18	14	19	5	19	12	20	3
100	18	4	18	10	19	0	19	6	19	12
110	15	10	16	0	16	5	16	11	17	0
120	15	8	15	13	16	2	16	7	16	13
130	14	4	14	9	14	14	15	3	15	9
140	13	10	13	15	14	4	14	9	14	14
150	12	7	12	11	12	15	13	4	13	9
160	12	4	12	8	12	12	13	0	13	5
170	11	9	11	13	12	1	12	5	12	9
180	10	10	10	13	11	1	11	5	11	9
190	10	9	10	12	11	0	11	4	11	8
200	10	4	10	7	10	11	10	15	11	3
210	9	13	10	0	10	3	10	7	10	11
220	9	8	9	15	10	1	10	5	10	7
230	9	3	9	6	9	9	9	12	10	0
240	8	4	9	1	9	4	9	7	9	11
250	8	10	8	13	9	0	9	3	9	7
260	8	8	8	11	8	14	9	1	9	4
270	8	3	8	6	8	9	8	12	8	15
280	8	1	8	4	8	7	8	10	8	13
290	7	12	7	15	8	2	8	5	8	8
300	7	11	7	13	8	0	8	3	8	6

Table showing the number of ends of cotton yarn from single 5s to 80s that will lie side by side in on inch.

Counts	Yards per lb.	Square Root.	Less 7 per cent	Diameter or Ends per inch.
5	4200	64.8	4.5	60.3
6	5040	70.9	5.0	65.9
7	5880	76.6	5.4	71.2
8	6720	81.9	5.7	76.2
10	8400	91.6	6.4	85.2
11	9240	96.1	6.7	89.4
12	10080	100.3	7.0	93.3
13	10920	104.4	7.3	97.1
14	11760	108.4	7.6	100.8
15	12600	112.2	7.9	104.3
16	13440	115.9	8.1	107.8
17	14280	119.4	8.3	111.1
18	15120	122.9	8.6	114.3
19	15960	126.3	8.8	117.5
20	16800	129.6	9.0	120.6
22	18480	135.9	9.5	126.4
24	20160	141.8	9.9	131.9
26	21840	147.7	10.3	137.4
28	23520	153.3	10.7	142.6
30	25200	158.7	11.1	147.6
32	26880	163.8	11.5	152.3
34	28560	168.9	11.8	157.1
36	30240	173.8	12.2	161.6
38	31920	178.6	12.5	166.1
40	33600	183.8	12.8	170.5
50	42000	204.9	14.3	190.6
60	50400	224.4	15.7	208.7
70	58800	242.4	17.0	225.4
80	67200	259.2	18.1	241.1

Conversion of Metres into Yards.

Metres.		Yards.
1		1.0936
2	=	2.187
3	=	3.281
4	=	4.374
5	=	5.468
6	=	6.562
7	=	7.655
8	=	8.749
9	=	9.843
10	=	10.936
20	=	21.873
30	=	32.809
40	=	43.745
50	=	54.682
60	=	65.618
70	=	76.554
80	=	87.491
90	=	98.427
100	=	109.363
200	=	218.727
300	=	328.090
400	=	437.453
500	=	546.816

Conversion of Yards into Metres.

Yards.		Metres.
1	=	0.91438
2	=	1.8288
3	=	2.7432
4	=	3.6576
5	=	4.5720
6	=	5.4864
7	=	6.4008
8	=	7.3152
9	=	8.2296
10	=	9.1440
20	=	18.2880
30	=	27.4320
40	=	36.5760
50	=	45.7200
60	=	54.8640
70	=	64.0080
80	=	73.1520
90	=	82.2960
100	=	91.4400
200	=	182.8800
300	=	274.3200
400	=	365.7600
500	=	457.2000

IDENTIFICATION OF TEXTILE FIBRES

	Vegetable Fibres					Artificial Fibres			Animal Fibres	
	Cotton	Linen	Jute	Hemp	Ramie	Viscose	Chardonnet	Acetate Silk	Wool	Silk
Burning	Burn rapidly with pungent smell					Burn rapidly with pungent smell		Forms beads	Burn slowly with characteristic smell	
Caustic Soda, 76° TW	Pale yellow Insoluble	Insoluble	Brown, Insoluble	Yellow, Insoluble	Insoluble	Un-changed	Dis integrated & partly dissolves	Fibre swells	Soluble, cold	Soluble, hot
Alkaline Lead	—	—	—	—	—	—	—	—	Black	—
Sulphuric Acid, 168°Tw.	Dissolves rapidly	Dissolves slowly	Dissolves slowly	Dissolves slowly	Dissolves slowly	Rapidly dissolves Brown			Insoluble	Dissolves
Nitric Acid	White Insoluble	Insoluble	Brown Insoluble	Yellow Insoluble	Insoluble	Dissolves rapidly with yellow coloration			Yellow, Insoluble	Yellow Dissolves
Ammoniacal Copper Solution	Soluble	Soluble	Insoluble	Insoluble	Blue Insoluble	Swells, disintegrates and is partly dissolved		Un-changed	Insoluble, cold	Soluble, cold
Aniline Sulphate	—	—	Yellow	Yellow	—	—	—	—	—	—
Acetone	—	—	—	—	—	Un-changed	Un-changed	Dissolves rapidly	—	—
Iodine and Sulphuric Acid	Blue	Blue	Dark Brown	Greenish-Yellow	Blue	—	—	—	—	—
Diphenylamine and Sulphuric Acid	—	—	—	—	—	—	Blue	—	—	—

Quick tests for textile fibres.

(1) Hold fibres in flame of match. Animal fibres burn Slowly, giving off a peculiar smell like burning hair, horn or feathers. The smoke reacts alkaline and turns lithmus blue. A small bead is also left at the end of the thread.

Vegetable fibres burn readily, giving an odour like burning paper. It leaves a whitish ash somewhat like the thread in shape. There is very little smoke or fumes which turns blue lithmus red.

Acetate rayon melts and forms a hard ball on the end of the fibre.

Silk burns slowly, gives a disagreeable smell, leaves a charred ash as a small globule which easily powders.

Cotton burns freely with flame, and the burnt end curls slightly.

Linen or flax burns also freely, but leaves a blunt charred end that does not curl.

(2) Boil the material in a 5% Solution of caustic soda for 15 minutes and the results will be as given in the above table.

(3) Treat fibres with cold, concentrated, sulphuric acid. See for results in the above table.

(4) Make up alkaline lead solution with 10 grams lead acetate dissolved in 100 c.c. distilled water. Add a 5% solution of caustic soda until the precipitate formed is just dissolved. Heat the fibres in this solution. Wool turns brown to black owing to the presence of sulphur.

(5) Treat the material with cold acetone, which is a solvent for acetate rayon unless the acetate rayon has been treated with caustic soda solution. On diluting the acetate solution with water, a precipitate of cellulose acetate is obtained. See table above.

(6) Hydrochloric acid—Dissolves cotton. Wool is untouched. Silk dissolves in a boiling strong solution.

(7) Ammonical copper solution is prepared by dissolving freshly prepared copper hydroxide is concentrated ammonia. Keep the solution in dark, well-stoppered bottles. The solution dissolves dry cotton (cellulose) at once. Silk dissolves. Wool, Jute, and Ramie do not dissolve. Ramie is stained blue. See table above.

(8) Use 1% aniline sulphate slution in water. See table above.

Plumbite of soda—Turns wool black but other fibres are unchanged.

(9) Iodine and Sulphuric. Two scales of iodine are moistened with 5 to 6 drops of alcohol. Add water until a slightly yellow solution is obtained. The material to be examined is moistened with dilute sulphuric acid (1 : 2) and then with the iodine solution. Fibres for microscopic examination are stained by this method see table above.

(10) *Cochneal Tincture*—When soaked in a solution of this, cotton is dyed light red, linen dyed violet, and wool and silk scarlet.

(11) *Diphenylamine Solution*—2 grams diphenylamine is dissolved in hot, dilute (1 : 3), Sulphuric acid; 300 c.c. of concentrated Sulphuric acid is then added. This solution stains nitro rayon blue, due to the presence of nitro groups in the rayon. (See table above)

(12) Use cold, concentrated, hydrochloric acid for silk—the result is that silk dissolves..

(13) *Olive oil*—If applied to a cloth containing cotton, cotton will remain opaque.

(14) *Mercerized cotton*—First remove all traces of starch from the sample to be tested. Immerse the sample in a strong, cold solution of zinc chloride in distilled water, and add a few crystals of iodine. The cloth will be coloured blue. Then wash the sample, and, if the colour remains, the yarn has been mercerized; if the colour washes out, the yarn has not been mercerized.

(15) *Cotton and Wool*—In a 5 per cent solution of caustic soda boil the sample for 30 minutes. Wool will be entirely dissolved and cotton will be left practically untouched. After about 10 minutes minutes boiling, add a few drops of acetate of lead, and, if wool is present, a black precipitate is formed, if a white precipitate is seen, there is no wool in the sample.

(16) *Colour tests for Rayon.*—Place sample in solution of Sulphuric acid and Iodine, equal parts.

(*a*) Acetate turns yellow.
(*b*) Nitro—cellulose turns violet.
(*c*) Viscose turns a dark blue.
(*d*) Cuprammonium turns light blue.
(*e*) Gelatine turns yellow—brown.

A test to differentiate between viscose and cuprammonium can be made as follows:—

Subject 5 grains of the unknown sample of rayon (viscose or cuprammonium) to the action of 100 c.c. of water, plus 3 c.c. glacial acetic acid, for a period of four hours in a diaphragm flask. The diaphragm consists of a filter paper, which has been saturated

with 10 per cent solution of lead acetate, securely fastened on the flange of the flask. If at the end of the four hours the exposed part of the lead acetate filter paper covering the flask becomes stained with a brown or a black colour, the fibre in question is viscose. If no colouration is obtained the sample is cuprammonium.

Sulphuric acid reduces silk to a brown solution. Add water and then a little tannic acid, and the silk is precipitated.

Hydrochloric acid and nitric acid dissolves silk (hot or cold).

Chloride of Zinc dissolves silk (in strong solution); dilution with water causes the silk to be precipitated.

Caustic potash or caustic soda, dissolve silks, particularly when warm.

Test for distinguishing between cotton and linen. Steep a sample suspected to contain these two fibres (cotton and linen) for 2 minutes in strong sulphuric acid, wash well with water, gently rub with the fingers, and finally steep in dilute ammonia; then squeeze and dry. The cotton fibre will be converted into a jelly—like mass by the action of the acid, and is almost completely removed by the rubbing and washing, the linen will remain practically untouched. By weighing the sample before and after the treatment an approximate idea of the amounts of cotton and linen present may be obtained.

To test for over-sizing.

The chemical used is methyl orange. If only a small amount of size is present, as for weaving purposes only, the methyl orange will retain its colour, but if a large perentage of size is present the solution will at once change to a pink or rose colour. This test can also be used, with the same results, to detect excess of acid in the cloth.

Test for Imported yarn,

After spinning, cotton yarn is 'conditioned,' *i.e.*, treated with a fine spray of water, or steamed in a room made for the purpose to give it the moisture necessary for imparting pliability—perfectly dry cotton being brittle. As cotton has hygroscopic properties which enable it to absorb up to 8 per cent of moisture (on the average) from the atmosphere, cotton yarn which contains that amount of moisture is called 'natural cotton.' Anything in excess is illegitimate.

Some spinners add calcium chloride or magnesium chloride or both, sometimes with, sometimes without, the addition of zinc chloride, thereby increasing the hygroscopic property of the yarn—which enables water to be sold as cotton.

Yarn should be tested, therefore, for the presence of 'chlorides' by steeping it in warm distilled water for some time and testing the liquor with silver nitrate solution. A white precipitate, insoluble in nitric acid and soluble in ammonia, proves the presence of chlorides.

In some cases it may be desirable, and even necessary, to add zinc chloride when conditioning, *e.g.*, in very coarse yarns which will be woven up after stocking it for some length of time to prevent mildew.

CHAPTER XLI.

BLEACHING.

The Process of Bleaching.

Colour is a physical sensation produced by the phenomenon known as light. Light is a form of energy, the most important source for the production of which, so far as this universe is concerned, is the Sun.

Other sources are often called artificial. All substances do three things to rays of light :—

(1) Absorb them.
(2) Transmit them and
(3) Reflect them.

If a substance absorbs all, or nearly all, the rays that fall upon it is said to be black; those bodies which absorb very few and reflect nearly all are termed white. Other substances absorb some and reflect others, and as our optic nerve (by means of which we see) only conveys to our brain the sensation produced by those rays which actually irritate it, that is, the rays which are reflected from the substances, our perception of colour will depend very largely upon the nature of the reflected rays. White substances reflect the light received practically unchanged. Now in bleaching, the intention is to so alter the surface of the material that it shall reflect as much white light as possible.

The Object of Bleaching.

The objects of bleaching are two-fold; firstly, to obtain a pure white and secondly, to produce pure cotton, that is to say, the removal of all impurities which would render it difficult to obtain light and bright shades in dyeing or pure whites in printing.

Impurities ;

The impurities to be removed consist in the natural foreign matter in the raw cotton (cotton wax, etc.) and the substances added by the weaver, viz. Sizing materials such as Starch, Tallow, etc. to assist these operations, and also incidental dirt, traces of oil, etc. Some of these substances absorb colouring matters, others retard the absorption, and as it is not to be expected that they will be evenly distributed throughout the material–unevenness results when

the material is dyed in light shades, or the whites of printed goods absorb colour and are stained. The loss in weight on bleaching yarn is about 6 to 8 per cent. This loss is chiefly due to natural impurities of raw cotton. Cotton piece goods generally lose from 10 to 15 per cent of weight, this extra loss representing the sizing materials added to the warp for weaving purposes, and is varying accordingly. There should be little loss in strength of yarn amounting to less than 5 per cent if the bleaching has been properly and carefully carried out. Piece goods do not lose in length, and their width diminishes by the mechanical stretching up to about 8%. This shrinkage is usually restored by stretching.

Textile materials may be and are bleached at all stages of manufacture, but the most important is the bleaching of cotton piece goods, which is generally carried out as follows :—

(1) *Stamping and Stitching*—The pieces are stamped with the number assigned to them, and conveyed to the stitching machine, where they are sewn end to end, and made up into batches of two or three tons. Great care must be taken in the stitching operation that the ends of the pieces are evenly joined.

(2) *Singeing ;* (burning off the nap & loose fibres).

(3) *Desizing ;* This is for removal of all sizing agents adhering to the cloth from the sizing operation, that is the preparation of the yarn for weaving.

(4) Hot and cold washing.

(5) *Pressure Boil ;* For several hours in a Pressure Kier with the addition of Caustic Soda or Soda Ash and preferably with an addition of an agent which cleans the cotton by emulsifying the waxes, etc., and thereby assures complete boiling out of the cloth, which is very essential for obtaining a full white (which does not turn yellowish and dull in storing) and ensures even shades if the material is dyed afterwards. Very helpful products for boiling out are Igepon T or Nuva LA. 6 to 10 lbs. of these chemical per 3000 lbs. cotton cloth (which is usually one Kier load) show a remarkable effect. If the cloth contains besides the natural waxes, oil or fat stains, an addition of Laventine is recommended. This pressure boil takes about 6 to 8 hours. If the cloth after this boil, is not cleaned enough, a second boil with an intermediate washing operation has to be given.

6. *Chemicking;* This is a treatment with a cold diluted solution of Calcium Hypochloride (Bleaching Powder) followed by a washing process.

7. *Souring* with diluted acid, which destroys the eventually remaining rests of Chlorine and besides improves the whiteness.

8. Final thorough washing, blueing and drying.

Previous to the bleaching operations proper, piece goods are usually stamped with gas-tar or some other substance capable of resisting the bleaching process, in order that they may be afterwards identified.

Singeing.

After being marked, the pieces are stitched together end to end, they are then passed through the singeing, which is carried out for the purpose of removing loose fibre from the face of the cloth and is performed by rapidly (at the rate of 80 to 150 yards per minute) passing the fibre over a hot plate or through a flame from a series of Bunsen Burners. Sometimes the process is repeated, and if a very smooth finish is required, it is carried out a third time.

Desizing.

The removal of all sizing agents from the cloth is very important as otherwise a lot of troubles may occur in the following bleaching and dyeing operations. All goods are mostly sized with Starch or starchlike products, which are water insoluble, and therefore stick to the cloth. Viveral is an agent, which if used even in the smallest quantities, renders the starches soluble in water, whereby they can be washed out completely. About 4 to 5 lbs. Viveral is sufficient to desize 3000 lbs. of cloth. The wet cloth from the Singeing Machine is passed through a washing machine which contains the Viveral Solution and is then piled up for several hours or over night. Then the cloth is washed hot and cold and is then ready for boiling out.

Pressure Boil.

The goods after desizing are passed immediately in rope form into the Kier where they are evenly piled down. The Kiers are then filled with the boiling out solution, containing for 3000 lbs. cloth about 60–80 lbs. Caustic Soda flakes and 7–8 lbs. Nuva LA and boiled up with steam. The manhole is then closed and boiling continues under about 5 lbs. to 40 lbs. pressure from 6–10 hours.

The liquor is then run off and Kier filled up with cold water at once in order to prevent damage to the cotton which is touching the hot sides of the Kier.

The Kier consists of a large cylindrical vessel made of steel boiler plate and capable of holding sometimes 3 tons of cloth. Means must be provided for continuous circulation of the liquors through every part of the mass of the cloth. The liquor is being constantly sprayed over the top, sucked away at the bottom and returned. Various means of achieving this end are adopted, thus giving name to the various types of Kiers. The simplest is the Injector Kier, where both circulation and boiling are effected by means of a jet of steam and circulating pipe. Condensation of steam increases the bulk of liquid in the Kier, and dilutes it to an undesirable extent. It is necessary that the goods should be evenly packed, because the liquor will take the easiest path, and tightly packed places would get little liquor. The action of the boil is to emulsify the fatty constituents in which state they can easily be washed off afterwards. The eventually remaining starch, which is made soluble in the desizing process, is also removed by the boil. Finally then the goods are rinsed well with water in a washing machine. After boiling, the goods may be treated in a weak cold Sulphuric or Hydrochloric Acid bath ($\frac{1}{2}$–1% solution of acid).

After this, the goods may, if found necessary, be subjected to a second pressure boil. The better the goods are boiled, the easier and more complete the bleach will be. The second pressure boil usually has the same contents of Caustic Soda and Nuva LA as the first boil. In this connection it may be mentioned that hard water causes precipitations with the alkalie (Caustic Soda) and soap or soaplike products if no Nuva or Igepon is used. The addition of Nuva or Igepon prevents all precipitations and thereby the well-known limestains, which cause a lot of trouble, are avoided. Instead of Caustic Soda, the somewhat more expensive Soda Ash may be used. Soda Ash has the advantage of forming with hard water, if no Nuva or Igepon is present, precipitations of Calcium Carbonate, which on account of their crystalline structure are easier to remove from the cloth than precipitations of Calcium Hydroxyde caused by Caustic Soda and hard water. If only Soda Ash is used, about $1\frac{1}{2}$ times the quantity of Caustic Soda is necessary to get the same effect.

An important fact is that air must be blown out of the Kier by means of steam before closing of the manhole, because by boiling cotton for so long a time in alkali in the presence of air, tendering

will occur due to the formation of oxycellulose. After well washing in water the cotton is now practically pure cellulose, all impurities having been removed except the traces of natural colouring. This resists all the previous operations, and although its quantity is small, the goods are still no lighter in colour than the original grey cloth.

Chemicking ;

The destruction of residual colour is effected by means of a cold, weak solution of Bleaching Powder. The solution used contains about two parts of fresh Bleaching Powder to 100 parts of water, but it is commonly made to a certain density and tested by a floating twaddel hydrometer in the solution, which is usually made to stand $\frac{1}{2}°$ to 1° TW. The twaddel is quite satisfactory for testing freshly made chemick liquor, but it is quite useless for old liquors. A very exact method to ascertain the strength of a bleaching bath is by titrating the bath with Arsenious Acid.

The goods are usually treated with chemick in a machine similar to a washing machine, and only remain in the liquor for a short time. They are then piled up whilst saturated with liquor, and allowed to lie in a piled state for several hours.

White Sour ;

The goods are drawn from chemick piles, washed with water and then treated with cold acid, Sulphuric or Hydrochloric Acid, about one per cent. strength as mentioned before after boiling. The materials are given a final thorough washing in water and then dried after blueing. Cotton should be practically as strong after bleaching as before the operation; if it be not, then the treatment has been some where at fault.

Lately, the Peroxyde bleaching comes more and more in use. The bleaching is effected here by Sodium or Hydrogen Peroxide. This process yields a very good white, which does not turn yellowish in storing, needs considerably less water, is less likely to tender the cloth and *the bleaching cost is about the same as the Chlorine Bleach.* For material intended to be dyed deep shaded black, etc., desizing is all that is usually required. Better work results, however, if the goods are given at least one alkali boil (Soda Ash), in order to remove the bulk of the fatty impurities which hinder the wetting out of the cotton and the penetration of the dyestuff. For medium shades, this at least is essential, and for light shades, a treatment with Bleaching Powder is also necessary in order that as light a ground

as possible is obtained at the commencement of the operation. It would be practically impossible to obtain delicate shades on cream ground such as light pink, sky blue, etc.

A Similar Method of Bleaching ;

Take 2000 pounds of cloth in one continuous form, wash in a washing machine with lukewarm water (Maximum 110° F.) containing $2\frac{1}{2}$ lbs. Viveral, after passing half the quantity of cloth add another $2\frac{1}{2}$ lbs. of Viveral. Pile the so impregnated cloth for several hours, then wash once hot and once cold. Now introduce the materials into the Kier containing 30 lbs. of soda and 5 lbs. Nuva LA. Boil for 8 to 9 hours. The pressure must be 10 lbs. and not more.

Thereafter draw the cloth out of the Kier, wash in water twice and then pass it through a solution containing 10 pounds of Perchloron, and then after passing half the quantity of cloth, add 8 pounds more of Perchloron. Repeat through Perchloron after allowing the cloth to stand in a heap 3 to 4 hours for the second time. For the third time wash twice and reduce Perchloron to 4 pounds per 100 gallons in a chemicking machine. Thereafter wash well in cold water containing $\frac{1}{4}$ to $\frac{1}{2}$ lb. Sodium Bisulphite per 100 gallons of water to remove the Chlorine, if any, left. The above given processes are only for white piece goods, which do not contain any dyed threads.

Bleaching of Coloured Goods.

In principle, the Bleaching Process for coloured goods is the same as for white goods with the only exception that the boiling process must not be so severe as for white goods, as the colours, even the fastest ones, will bleed and spoil thereby the goods. After desizing with Viveral as mentioned for white goods, the coloured goods are not boiled in pressure Kiers, but only treated in open Kiers at atmost 140° F. with 2-3% Soda Ash, and 0.3% Nuva LA. If one boil is not sufficient, a second boil has to be given, but the temperature should under no circumstances be increased. For coloured goods only the fastest dyestuffs can be used, namely the Indanthrens and some selected brands of Naphtols. As sometimes a certain pressure acts upon these goods which are at the bottom of the Kier and besides the impurities of the cotton act as reducing agents which dissolve Indanthrens, a certain bleeding may take place. Though this bleeding happens very seldom if all precautions are taken, it is useful to know that Ludigol counteract

this reducing power of the boiling out liquor and prevents bleeding if small quantities are added to the boiling out bath. Chemicking, etc. is carried out in the same way as mentioned above, but also care should be taken here that the treatment is not so severe.

The Peroxyde bleaching process is specially suited for Indanthren coloured goods, as the whiteness is better, the shades appear more brilliant, the process is very short, less water is required and the cost is about the same as for Chlorine Bleach.

Yarn Bleaching.

Take at the rate of 2 per cent. Caustic Soda and 0.3 per cent. Nuva LA on the weight of yarn and add it to the Vat containing about 600 gallons of water for the purpose of boiling. If three hundred pounds of yarn are to be boiled, take 6 pounds of Caustic Soda and 6 oz. Nuva LA, boil for 24 hours, wash twice in cold water and then introduce in a Vat containing Perchloron. For a start, put 3 lbs. and for every subsequent 100 pounds add 2 pounds of Perchloron, and then introduce it in a Vat containing 2 pounds of Sulphuric Acid and then for every subsequent 100 lbs. 1½ pounds of Sulphuric Acid to be added, wash twice with cold water. An addition of Nuva or Igepon is very essential in yarn bleaching as yarn is mostly dyed after bleaching and if the boiling or bleaching was incomplete or lime stains from the water, which are prevented by Igepon or Nuva, occur, the dyeings are bound to become uneven

Waste Heat can be Utilised.

In a Bleaching and Dye works there are numerous points at which heat can be used to provide hot water for the various processes. The arrangement can be done at a very small cost at the beginning and it will save an enormous sum of money in the long run.

Stretching or Stentering.

Goods passing through the processes of bleaching, dyeing, etc. invariably lose in width, and may be as much as 10 per cent. from the grey width. They do not lose in length. The lost width is regained as much as possible on the stretching machine. The stretching machine consists of two nearly parallel chains of strong clips which grip the selvedge of the cloth as it enters, and as they move along, they expand slightly, and thius the cloth is pulled out. The cloth enters the machine slightly damp or is damped with steam while passing through, and is dried by a heating arrangement whilst passing along, still under tension. Excessive stretching impoverishes and weakens the fabric.

CHAPTER XLII.

MECCERISING.

Mercerising is associated with cotton materials of silk-like lustre and softness. Yarn or cloth immersed in a strong solution of Caustic Soda (exceeding 10 per cent.) crinkles up and acquires a harsh feel. By washing well in water this harshness is removed and the material appears more transparent. If measured a loss of about 10 per cent in length will be noticed, but if tested for strength, it will be found to have increased by at least 30 per cent. and it increases the weight by about 5 per cent., retains about four-fifths of the elasticity of the grey yarn. Cotton yarn and cloth is kept under tension whilst treating it with, and whilst washing away the alkali, and thus it acquires a silky lustre. Tension is necessary to produce the lustre and prevent shrinkage. All yarns to be mercerised must first be gassed, as the loose fibre cannot be tensioned and would therefore not be lustrous, but cover up the lustre on the thread itself. The piece goods are impregnated with cold strong Caustic Soda by passing through a 'padding' bath and mangle with one steel and one rubber roller. From this the cloth passes immediately to a stretching frame where it is gripped along the selvedges by strong clips, and pulled out to the original grey width. Whilst on this frame, it is sprayed with water in order to wash away the alkali. Lately, also so-called Chainless Mercerising Machines for piece-goods are brought on the market, which also work satisfactorily. The process is continuous and only a short time is allowed to elapse between the operations of impregnating and stretching. The time of impregnating is only a matter of seconds, the period during which the cotton is in contact with the alkali being only from 30 to 60 seconds. After washing with water, the material is 'soured' in order to remove all traces of alkali, and again washed to remove the excessive acid. Short fibre gives but inferior results in mercerization and therefore with American cotton well-combed yarn is preferable. Egyptian yarn is usually used for mercerised goods and even then in the form of doubled yarn, in order to reinforce the resistance of the twist to the shrinkage action of the alkali. The lustre and softness of mercerised goods is quite permanent, resisting any amount of washing, and even a full bleaching process. By mercerising the cellulose is chemically changed into a Hydrate Cellulose which has quite different properties from the usual cotton, such as an increased

affinity for dyestuffs, and also the shades obtained are brighter than those produced on ordinary cotton by the same dye-stuff. The mercerizing of yarn is employed chiefly for yarns intended for weavings in colourings–such as, stripes on plain grounds or fancy designs. Coloured yarns intended for dhoty borders if they are mercerized before they are dyed, give a very good effect to the borders for which a higher price can be demanded and obtained. Mercerized yarn has a greater affinity for moisture than ordinary cotton. An allowance of 11 per cent for moisture is allowed for mercerized yarn against 8.5 per cent. for ordinary cotton yarn. In mercerizing, the fibres become thicker and of greater diameter. This increases the cohesion of the fibres and gives greater tensile strength to the yarn.

How to test Mercerized Yarn or Cloth.

The best chemical test to apply to yarn or cloth to detect mercerization is to treat the cotton with a cold saturated solution of Zinc Chloride, Potassium Iodide and Idodine.

The reagent is prepared by dissolving

30 grams Zinc Chloride pure solid,
5 ,, Potassium Iodide
1 ,, Iodine (in 24 c.c. of water).

It should be kept in a small glass-stoppered bottle. If the sample is white, it may be used without previous preparation. If it is coloured, it must be first bleached and dried before the test is applied. A very small piece (if cloth) or a few strands (if yarn) are immersed in the dry condition for two or three minutes in the liquid, and then transferred by means of a glass rod to an evaporating dish nearly full of water. By means of the rod the cotton is kept under the surface of the water, and moved about to wash it. If the cotton material has not been mercerized, the dark blue colour will gradually become fainter and ultimately disappear. In the case of mercerized cotton, the colour remains a distinct blue.

A Simple form of the Cotton Mercerization Test.

First, the iodine Solution itself is made by dissolving 20 grams of iodine in 100 c.c. of a saturated solution of potassium iodide. The small patterns of mercerized and unmercerized cottons are then steeped for about one minute in a few c.c. of the iodine solution, then withdrawn, and afterwards left in running cold water for several

minutes. At first, both patterns will be dark blue, but gradually in the washing the unmercerized cotton will lose its colour whilst the mercerized pattern will remain distinctly blue. In a general way the depth of blue on the mercerized pattern will be a measure of the degree to which it has been mercerized.

Armchair Theorizing.

In most things connected with chemical processes the most satisfactory course is to experime t and experiment—armchair theorizing can often prove to be a real stumbling block to the acquisition of new knowledge.

Causes of Damages of Bleached Cloths.

(1) Mineral oil stains, derived from lubricating oil used in Machinery. These may be removed by organic solvents such as Petrol, Benzene, soap, etc.

(2) Lime stains may be produced by bad boiling or plaiting in Kiers. Deficient circulation of liquor in Kiers, too strong a liquor, incomplete souring of the goods. Such stains may also occur in soda boil for similar reasons.

(3) Mechanical Damages in bleached cloths caused by bleaching machinery may occur at any stage of the processes, such as, bowking, kier boiling, souring, Chemicking, or washing. These can only be stopped by careful handling, strict supervision, and overhauling of the bleaching and washing machinery.

(4) Lead stains are similar in appearance to those caused by iron and are caused by contact with dirty lead pipes. They cannot be removed as a rule. But they will in some cases dissolve in dilute nitric acid or solution of ammonium acetate.

(5) Iron stains due to rust in kiers or other machinery may also arise due to the presence of iron in water or chemicals used for bleaching. These are easily removed by rubbing the fabric with strong concentrated oxalic acid solution.

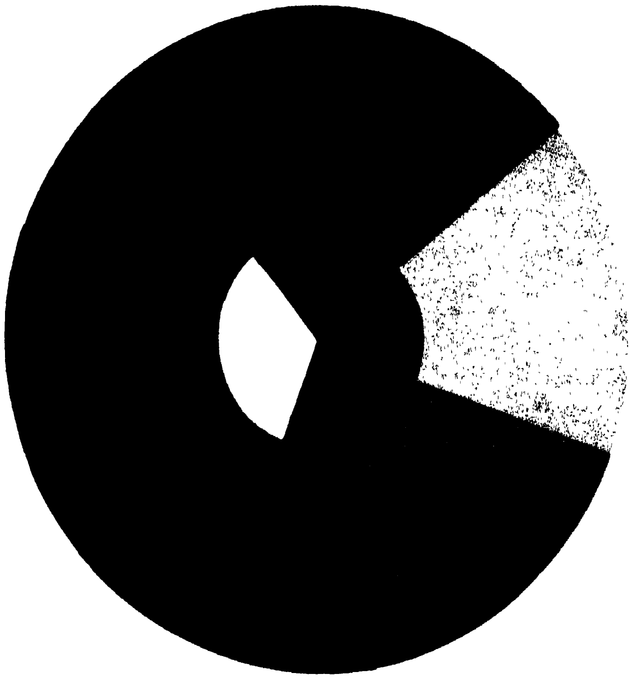
(6) Tenderness of cotton fabrics may be due to (a) oxycellulose produced in the lye boil or by over-bleaching or by the presence of chloramines, owing to the action of chemic or unremoved proteids (b) Hydrocellulose produced generally by the presence of unremoved mineral acid.

(7) " Discolouration and Stains caused by incomplete bottoming in bowking." Any residual colouring matter left in the fabric after this process gradually reappears on the surface producing loss of colour which is generally caused by rosin and other soaps. The process depends upon the liberation of the fatty or rosin soaps and then the subsequent removal of sodium salts by reboiling and washing.

(8) Hydrocellulose is formed by leaving traces of mineral acid in the cotton by incomplete washing. Goods containing hydrocellulose or oxy-cellulose go brown and disintegrate gradually on storing with loss of tensile strength.

(9) Over bleaching may be caused by (a) leaving goods in chemic too long or at an unsuitable temperature (b) using too concentrated a chemic (c) leaving goods lying exposed to the air when saturated with chemic.

Colour Chart.



Number of Colours——In an estimate described in Textile in 1939 there are 9,253,292 colours. The National Bureau of Standards at Washington estimates that there are 2,000,000 colours, each one differing from its neighbour by one unit. As it is possible under proper illumination to detect colour differences of one-fourth or one-fifth of a unit, a conservative estimate places the number of distinguishable colours at 10,000,000.

CHAPTER XLIII

DYEING.

Dyeing is the art of producing a colour on fibres, cloths, fabrics and other articles. For a coloured substance to act as a dye-stuff, there must exist an affinity between the fibre and the dye-stuff. The dyestuff is more or less absorbed by the fibre, and retained more or less permanently thereby.

The chief groups of dye-stuffs employed in dyeing cotton yarn or cloth are :—

(*a*) Direct Cotton Dyes,

(*b*) Basic Dyes,

(*c*) Sulphur Dyes,

(*d*) Vat Dyes (as Indanthren, etc.)

(*e*) Insoluble Azo Colours (which are produced on the fibre as Naphtol, Para Red, etc.)

(*f*) Aniline Black

(*g*) Mineral Colours (Mineral Khaki, Prussian Blue, Chrome Yellow, etc.)

(*h*) Mordant Dyes (the wood dyes, Turkey Red, the Chrome Colours, etc.)

The Direct Dye-Stuffs.

This name was given because the Colour can be applied direct to the cotton fibre without first treating it with a fixing chemical.

The First Operation in Dyeing:—

The first step is always the preparation of fibre or fabric. Dye liquor must penetrate the fibre in order to produce a permanent and level result. Therefore, all fat, filling and injurious substances must be removed, and if the colour desired is a light shade, the natural colour of the yarn must be removed by bleaching. To get rid of the fat and grease, cotton is boiled in a solution of very dilute Caustic Soda, or a 1% to 4% solution of Soda Ash, calculated on the weight

of the yarn, for 4 or 5 hours, and afterwards well rinsed in clean hot water. A very useful auxiliary for boiling out cotton is Igepon T. Igepon T is a soap-like product, which, contrary to ordinary soap, *does not form any lime soaps with hard water*, but has a very good cleansing power and emulsifies the natural cotton waxes. Additions of 1/4 to 1/2% Igepon T, calculated on the weight of the goods, show a remarkable effect.

If cotton yarn, or cloth, which contains excessive amount of oil or fat, are to be boiled out, it is advisable to add Laventine HW. This chemical, if added to the boiling out solution, removes completely all fat or oil stains.

This is called "Boiling Out."

Application of Dye-stuff to Cotton Fibre :—

All dye-stuffs must be dissolved in water. Whilst Direct and Basic dye-stuffs are soluble in plain water, others need certain Chemicals for disolving; for instance, Vat dye-stuffs are only soluble in alkaline water, containing a reducing agent like Hydrosulphide. Sulphur Colours are dissolved by boiling in water containing Sodium Sulphide and Soda Ash.

Ordinary Direct cotton colours are usually dissolved in hot water with the addition of a little Sodium Carbonate or Sodium Phosphate to make the solution more perfect. The actual dyeing process is very simple. The dye-stuff is dissolved in hot water and added to the dye bath (for yarn 20 times the weight of material to be dyed) which is boiled up. The goods are entered and worked for a short time, and then the salt is added; about 15 to 25% Glaubers Salt Calcinated or common salt, being used according to the depth of shade to be dyed. If Glauber Salt or common salt is added to the dye bath, the dye-stuffs exhaust more completely. For pale and medium shades, it is not advisable to use Glauber Salt or common salt, as the dye baths which contain only small amounts of dye-stuffs exhaust nearly completely, and an accelerator, as Glauber Salt, may in this case, cause uneven shades. The slower the dyestuff goes on the fibres the evener the shades that are obtained. This is very important for pale shades. A so-called levelling agent, which slows down the dyeing process, is Igepon T. It is advisable to use 4 to 8 oz. of Igepon T for 200 gallons dye bath for obtaining evenness in light shades. The dyeing process is carried out for ¾ to 1 hour near the boil.

To Determine the Quantity of Dye-stuff to be used ;—

First, select on a pattern card the shade desired. This will give: 1) percentage of dye-stuff required; (2) percentage of chemicals, etc., which are used in the dyebath. This percentage refers to the weight of the material to be dyed. The next step, therefore, is to weigh the cotton yarn or cloth in dry condition before or after boiling out, and then calculate the weight of the dye-stuff and chemicals to be dissolved in the bath. Percentages in dyeing are calculated on the weight of the goods and bear no relation to the strength of the dye solution. Thus 3% dyeing means that 3 lbs. of dye are used per 100 lbs. of material to be dyed, and 15% of salt means that 15 lbs. of salt are added for each 100 lbs. of cotton to be dyed. The process of dyeing is by no means so simple as the use of home dyeings would lead one to think. The Dyer has not merely to produce a colour, but to match a given shade from a pattern-supplied. The dyeing must be per-fectly even over a large bulk of material, and the colour must meet certain more or less severe demands of fastness according to the market for which the goods or yarn are intended.

The Volume of the Dye Bath (Size of Vat $=8' \times 2\frac{1}{2}' \times 2\frac{1}{4}'$.)

As the quantity of liquor will affect the strength of the solution, and the strength of the solution will materially affect the shade and other features of the dyed goods, the volume of the dye bath is a very important factor. The amount of water used depends upon the type of goods being dyed and upon the kind of machine being used. It should be the minimum, consistent with the correct working and even dyeing. If the yarn or fabric is immersed in the dye bath for a few seconds, it will be only tinted; if immersed for a longer period, it will be more deeply dyed. Still deeper and faster dyeings will be obtained by dyeing near the boil. As the dye-stuff is taken up by the fibre, it is obvious that the quantity becomes exhausted. It is not often that this exhaustion is complete; there is some kind of balance between the relative affinities of the dye-stuff solution and fabric of yarn. It is found in practice that for every 100 lbs. of material 200 to 250 gallons of water for the bath give the best result in the case of yarn dyeing.

Temperature for carring on Dyeing Operation ;—

The most successful dyeing is obtained by entering the goods when the bath is luke warm (say 40° C.), then gradually raising to

the boil and keeping near the boil for about 30 minutes. If the bath is too hot when the yarn is entered, the colour "rushes on" and produces uneven dyeing.

Precautions and Manipulations necessary for the process of Dyeing :—

The hanks or fabrics should be put into the bath in a uniformly wetted condition, but not heavily charged with liquor. They should be wrung well, shaken out to ensure even wetting, and immersed as quickly and completely as possible. They should be turned all the time they are dyeing, to ensure evenness, and to keep the bath at a uniform temperature. The yarn or goods must be kept in motion during the dyeing operation, and mechanical means are adopted for doing this.

The water used must not be hard. As many dye-stuffs are affected by lime or Magnesium salts (precipitate and dull shades), hard water should be corrected by the addition of soda ash which also facilitates the wetting-out of goods and promotes even dyeing, so that it is common to add about 1/2% to 1% of soda ash to the dye bath. For similar reasons, soluble oil or soap is sometimes added, especially for very light shades. Igepon T, as already mentioned before, has a very good levelling power and is not affected by hard water, contrary to soap which has detrimental effects by the formation of lime soaps which stick to the material.

Reasons for adding various Chemicals to the bath.

Sodium Carbonate is added

(1) to soften the water,
(2) to ensure complete dye-stuff solution,
(3) in some cases, the dye-stuff exhausts better in alkaline baths.

Glauber Salt (Sodium Sulphate) is to render the dyestuff less soluble, in other words, to throw the dye out of solution, so that more is taken up by the fibre. As it is, these baths are rarely completely exhausted.

Common salt is used for a similar reason, as it is cheaper than Glauber Salt, but not quite so good for light shades.

If dark shades are dyed without the addition of Glauber Salt, etc., about 2/3 of the dye-stuff taken will remain in the water, and about ⅓ will have been absorbed by the cotton. It is found that by

adding salt to the dye bath, the proportion of the dye absorbed by the cotton, is much increased, and, as the common salt is cheaper than the dye-stuff this addition is always made. By adding about 15% of salt the proportions of the dye absorbed by cotton and left in the water are approximately reversed—about two thirds will be absorbed and retained by the cotton, while one third will be left in the dye bath. It is not possible to obtain complete absorption of the dye from the water by cotton except in the case of light shades. From one per cent. to two per cent. of dyestuff calculated on the weight of the cloth, will be required to produce medium shades, from 3 per cent. to 4 per cent. for dark shades, and from 4 per cent. to 6 per cent. for blacks.

Manipulations needed after removal of yarn fromthe Dye Bath.

Directly the yarn or fabric is removed from the bath after dyeing for the requisite time, it should be well washed in running cold water until all loose dye liquor is removed, well hydro-extracted or wrung in the case of yarn and dried in the air or in a drying chamber in the case of yarn or a drying range, in the case of fabrics, which is heated by means of steam. For obtaining the best results, all fast colours (Indanthrens and Naphtols) are soaped after washing, i.e. they soaped after washing, i.e. they are worked for 20 to 30 minutes in dilute solution of pure soap and water at a temperature near the boil or at full boil, and then dried after re-washing, particularly in the case of Naphtol, soaping is absolutely necessary, as by this process the exact shade gets developed and the best grade of fastness is obtained. Also here, Igepon T is of the greatest help as an addition to the soap baths, as lime soap precipitations, which stick to the material, render the shades dull.

Testing Direct Colours :—

Congo Red, Chrysophenine, etc. These colours bleed; when boiled in dilute soap solution the latter becomes coloured. If a piece of white cotton is heated in the solution it takes up the colour and remains dyed. Congo Red very easily turns black with a drop of Hydro-chloric or Sulphuric Acid (diluted). These are not fast to bleaching.

Fastness of Direct Colours :—

Direct Cotton Colours, as a class, are by no means fast, but they satisfy many requirements in this respect and are very largely used. A few can

be considered fast to light which are to-day known under the name Sirius and Sirius Supra Colours (fastness to light 5 upto 7). Many of the direct colours may be rendered fast to light by very simple after-treatments. None is fast to washing with boiling soap, and they will bleed considerably when thus treated, and will stain white materials which may be boiled alongside. They are of good fastness to rubbing, i.e. they will not easily stain a white fabric which is dyed on the dyed goods. They will all mix freely with another and may be dyed in mixtures, thus rendering it comparatively easy to produce any shade required, or to alter it by additions to the dye bath during dyeing, should the shade not exactly match the desired pattern. As a class, they are cheaper per lb., and much easier and cheaper to dye than most other dye-stuffs. They are of good brightness of shade, and this may be improved by "topping" with Basic Colours.

After-Treatment :—

There are various more or less simple means by which the fast-ness to light or washing of some of the Direct Cotton Colours may be considerably increased. The Direct Colours, although much improved in fasteness by these various means, are still not so fast as some of the Mordant and vat Colours. They can usually be discharged by Hydrosulphite, and on this account are useful to the Calico Printer for white or coloured discharge effects on a moderately fast ground. The Direct Dyes may be distinguished on the fibre bleeding when boiling in soap solution and by staining white cotton with it (unless aftër treated). They are destroyed by bleaching powder solution and by hot hydrosulphite solution (except Primuline, and certain other Direct Yellows).

Fastness of Colour :—

The term "Fastness" is only relative and the fastness various varies within wide limits according to the particular requirements of the materials upon which the colours are dyed. It is probable that no single dye-stuff would stand up satisfactorily to all the various fastness requirements. Even not all Indanthren colours stand up Satisfactorily to all the various fastness requirements. The more important demands are for fasteness to "light and washing.

Fastness of Light :—

Take a piece of glass about 4 inches $\times 6$ inches, and cut a piece of white cardboard of the same size. Bind them together along one edge by means of a strap of photographic adhesive "Leatherette."

On the top of the card-board, put a piece of black paper, on the top of this a piece of white filtered paper, and on the top of this a few strands of dyed yarn which is to be tested. Cover half of it with two thickness of black paper and let the glass fall into position. The remaining three edges can now be bound, or two rubber bands can be passed round. The whole arrangement can now be exposed to bright direct sunlight for days or weeks (if necessary). The degree of fastness is judged by comparing the portion exposed with what was kept under the black paper. The fasteness to light is much influenced by the humidity of the atmosphere in which the patterns are exposed. To this is due the fact that some dye stuffs withstand the light better in the drier atmosphere of India than in England.

Fastness to Perspiration (*street mud, etc.*) ;—

For testing these fasteness properties of a dyed material, a cutting of the dyed cotton is steeped together with a cutting of bleached cotton in a solution, at 45° C., for 1 hour, containing per litre

5 lbs. common salt
6 c.c. Ammonia.

After 1 hour 7.5 c.c. of Acetic Acid (Glacial) are added to this solution and the 2 cuttings are treated for half an hour more. Then the samples are taken out, squeezed well and dried without rinsing. The fastness to perspiration can be ascertained by the change of the original shade and the more or less tinting of the bleached cotton which was treated in the same solution.

Fastness to washing :—

May be tested by

(1) boiling a pattern in a weak soap solution (about $1\frac{1}{2}\%$) for about 5 to 10 minutes, alongside a piece of white material. The bleeding out of the colour, if any, the extent to which the white material is stained, and the final shade of the original pattern, for the basis of comparison.

(2) steep for 5 minutes in one per cent. solution of Sodium Carbonate. Fastness to milling includes a rubbing operation in the soap solution during the above test.

Fastness to Bleaching :—

Almost any colour, except Indanthrens and Naphtols, can be wholly or partly bleached if the bleaching process be intense enough. Make a solution of fresh bleaching powder, strength 5

gains per 100 c.c. and filter. Steep the dyed yarn in the cold filtrate for ten minutes and without squeezing or washing put it in dilute acetic acid or dilute sulphuric acid (1° TW.) for 10 minutes. Remove, wash well under running water, and dry in the air.

Direct Colours.

"*Dyeing Recipes*" *for* 100 *lbs. cotton yarn in* 200 *gallons liquor.*

	Starting Bath	Standing Bath.
BLACK		
Oxydiamine Carbon JE	3 lbs.	2¼ lbs.
Soda Ash	1 "	½ "
Common Salt	20 "	5 "
BELZO-RED. (Not fast to acid).		
Cotton Red 4BX	3½ lbs.	2 lbs. 10 oz.
Soda Ash	1 lb.	½ lb.
Glauber Salt	20 lbs.	5 lbs.
RED (Fast to Acetic Acid).		
Deltapurpurine 5B Conc. ..	4 lbs.	3 lbs.
Soda Ash	1 lb.	½ lb.
Common Salt	20 lbs.	5 lbs.
CHOCOLATE.		
Diamine Bordeaux VBI	3 lbs.	2¼ lbs.
Soda Ash	1 "	½ "
Glauber Salt	20 "	5 "
DARK BROWN.		
Cotton Brown A	3 lbs.	2¼ lbs.
Soda Ash	1 "	½ "
Common Salt	20 "	5 "
ORANGE.		
Benzo Fast Orange S	3 lbs.	2¼ lbs.
Soda Ash	1 "	½ "
Glauber Salt	20 "	5 "

	Starting Bath.	Standing Bath.
LEMON YELLOW.		
Khaliff Yellow SYZ	½ lb.	6 oz.
Soda Ash	1 ,,	½ lb.
Common Salt	10 lbs.	2 lbs.
LIGHT BLUE.		
Oxamine Pure Blue 6BO ..	3 oz.	2½ oz.
Soda Ash	1 lb.	½ lb.
Common Salt	6 lbs.	2 lbs.
LAVENDER (Fast to light.)		
Sirius Violet BB	6 oz.	5 oz.
Soda Ash	1 lb.	½ lb.
Common Salt	5 lbs.	1 lb.
GREEN (Fast to light)		
Sirius Supra Green BL ..	3 lbs.	2¼ lbs.
Soda Ash	1 ,,	½ ,,
Glauber Salt	20 ,,	5 ,,
GREY (Fast to light)		
Sirius Supra Grey R	½ lb.	7 oz.
Soda Ash	1 lb.	½ lb.
Common Salt	5 lbs.	1 lb.

"Basic Dyes."

As a rule, for brilliancy of shade, the Direct Dyes are much inferior to another class called the "Basics"–so named because the dye-stuffs contain in their molecule certain Basic groups. The Basic Colours have not had nearly so large an application as Directs, chiefly for two reasons :

(1) They are much more fugitive to light and washing.

(2) For vegetable fibres, they cannot be dyed in one operation. (For animal fibres, they can) The fibre must be mordanted with certain chemicals in order to fix the colour on the fibre.

Unlike the Direct Cotton and Sulphur Colours, they are not absorbed and fixed by pure cotton, nor are they dyed satisfactorily by the methods used for dyeing the natural colouring matters. They are easily dyed on wool and silk, but in order to dye these very brilliant colours on cotton, it is necessary to devise special methods. Some satisfactory "mordant" had to be sought which could be fixed on cotton and would, in turn, absorb and fix the Basic Colour. The desired substance was found in the tanning materials used for hardening animal skin to make leather. These all contain a substance called Tannin Acid.

Mordanting.

A mordant is a substance which is capable of being absorbed by a fibre, and which, when brought into contact with a dye-stuff forms a compound with it in the interstices of the fibre, and thus prevents its easy removal by washing. Substances which are capable of acting as mordants to cotton are

(*a*) Tannic Acid
(*b*) Turkey Red Oil
(*c*) The Direct Cotton Colours (to a very small extent)
(*d*) Katanol ON, which is, contrary to Tannic Acid, not sensitive to Iron.

The cotton yarn is well worked in these, but if Tannic Acid is used another process is necessary to fix it on the fibre before putting it into dye bath. Several substances can be used for this purpose: the two in general use are :

(*a*) Tartar Emetic (a compound of Antimony)
(*b*) Ferrous Sulphate.

The Antimony Tannate, which is thus fixed, is almost colourless and therefore allows the dyeing thereon of the lightest and brightest shade. The iron salt is used only for dark shades namely Violet, Blue, and Black.

Mordanting & Fixing:—

The process is carried out by taking sufficient water (proportion of material to water =1 : 20) to cover the goods and ensure easy working and an even absorption of the Tannin, but the actual proportion of water necessary must vary with the class of goods in process and the type of machine being used. Too little water will

mean uneven tanning whilst too much will mean wastage of Tannic Acid, because more will then be needed to prduce the same depth of shade when dyed. The boiled-out yarn is put in a bath of cold Tannic Acid, heated to 120° F. and then allowed to cool down or "feed" in it for some hours—say, all night. After removal, the yarn is squeezed uniformly, and put into the cold fixing bath for ½ hour. Of course, the yarn is turned at intervals during the immersion. After removal from the fixing bath, it is squeezed and rinsed, when it is ready for the dye bath. A light cold water washing before dyeing renders the resulting shades faster to rubbing by removing loose Tannin–Antimony lacquer from the surface. Cotton piece goods may also be modanted by padding in strong solution of Tannin, squeezing evenly and drying. The fixing bath may be used repeatedly by freshening up with Tartar Emetic, but a little soda or chalk must be added to neutralize the free acids which accumulate. Fixing with iron is done in a similar way, using various iron salts (e.g. Nitrate of Iron.).

Quantities of Mordant & Fixer to be Used.

Tannic Acid, from 1 to 2 per cent. for light shade, from 3 to 4 per cent. for medium shade, from 5 to 6 per cent. for dark shade. These percentages are for starting bath and for standing bath 3/4 of the above quantities will do.

Preparation of the Dye Bath.

The method is similar to that described for Directs, the calculation for quantities required being identical. The bath is generally made not quite so short at least 20 of liquor to 1 of material being used–and no Soda Ash or Glauber Salt is added, but as a rule a little dilute Acetic Acid (2 to 3 per cent.) or 2 to 4 per cent. alum is advisable, and heated to about 120° F.

The Temperature.

The temperature, when the yarn is entered, should not exceed 40° C., and it may be colder with advantage. If higher, the colour tends to rush on, and uneven dyeing is the result.

Dyeing.

Only about 2% of colour is necessary to give full shades, as these dyes are of high tinctorial strength. The necessary dye is dissolved in hot water with the addition of about twice its weight of

commercial Acetic Acid. The dissolving of the colour is very important and too easy. A portion of the dissolved dye is now added to the dye bath, and the good worked therein for a few minutes, lifted out of the liquor whilst more dye is added in three or four portions during about 20 minutes at about 120° F.

Precautions in Dyeing Basics.

To obtain really good results in dyeing Basic Colours, several precautions are necessary. One of the most important ones is the necessity for pure water. Hardening salts produce uneven dyeing much more readily than with Directs due to precipitation of the colour. Peaty matter and the slightest trace of iron salts also spoil the shade. Wherever iron is likely to come into contact with the dye–liquor or the material, the mordanting with Tannic Acid should be avoided and Katanol ON should be used instead, e.g. dyeing in iron jiggers and so on. The precautions of adding the colour in several portions is necessary owing to the great tendency of these dyes to dye unevenly. The Acetic Acid is present for the same purpose as it retards the speed of absorption of the dye-stuff. Continual movements of the goods are essential. Even with all precautions, it will be found on cutting that thick or tightly woven material is not fully dyed through, and the interior fabrics will be lighter in the shade. A new levelling agent for Basic Colours is Peregal O. The chemical, if added to the dye bath, slows down the dyeing process thereby producing even shades and best penetration of the dye-stuffs. If no levelling agent is used, the dye rushes on the fibre and is only fixed on the surface, whereby uneven shades and incomplete penetration are caused. Also the fastness to rubbing is very bad if the dye-stuff is only fixed on the surface.

After dyeing, the goods are well washed and may be treated with Tannin and Tartar Emetic (half the quantity taken for mordanting) or pass the material once more into the old mordanting baths, will improve fasteness to rubbing, washing and fastness to boiling with acids.

Brightness and Fastness.

The Basic Dyes give the brightest shades obtainable on cotton, and are, therefore, much used, but unfortunately, brightness and fastness do not usually run in parallel. They are, as a class, of poor fastness to light, particularly the brightest of them, the Methyl Violets and Victoric Blue. These will fade completely in less than a

week's sun shine. There are some of better fastness amongst the less brilliant shades. The fastness to light of some of the Basic colours can be improved by an after-treatment in a bath containing 1 to 2% Auxamine B (reckoned on the weight of the material) 20 to 25 grammes per litre common salt, 7 to 10 c.c. per litre acetic acid. Treat the well rinsed dyeings for half to three quarters of an hour at 25 to 30° C. Squeeze or hydro-extract without washing. Generally the fastness to light will improve from 1 or two upto 3 to 5. The Basic Dyes are faster to light when dyed on wool and silk on which fibres they are dyed without the aid of mordants, or any previous treatment of the fabric other than wshing. The dyeing process for these fibres is much the same as that for tanned and fixed cotton.

Katanol.

This is a new synthetic mordant for Basic Dyes which simplifies the process by eliminating the fixing in Tartar Emetic. Katanol is dissolved in hot dilute Sodium Carbonate solution, salt is added, and the cotton worked in the hot liquor for 30 to 40 minutes, rinsed in water, and is then ready for dyeing with Basic Dye-stuff. The shades obtained are sometimes brighter and faster to washing than those mordanted with Tannin. Katanol has also the great advantage of not being sensitive to iron as Tannin.

The most important Basic Dyes used in Dyeing are :—

Auramine (Yellow)
Bismarck (Brown)
Brilliant Green
Chrysoidine (Orange)
Magenta (Red)
Methylene Blue
Methyl Violets
Malachite Green
Rhodamines (Red)
Safranine (Red)
Victoria Blue.

Tesf for Basic Colours:—

When treated with dilute Caustic Soda, the shades fade away and are destroyed. They are easily stripped in hot spirit (alchohol). The Basic Dye is taken up by the spirit and this solution diluted with water and acidified dyes a small cutting of cloth which is mordanted in Tannin.

Basic Colours.

The yarn must be first mordanted and then dyed.

	Starting Bath	Standing Bath.
Mordanting Light Shade.		
Tannin Bath	1 to 2%	Take fresh bath.
Fixing Light Shade.		
Tartar Emetic	1 to 2%	do
Mordanting Medium Shade.		
Tannin Bath	$1\frac{1}{2}$ to $2\frac{1}{2}$%	$1\frac{1}{8}$ to $1\frac{1}{2}$%
Fixing Medium Shade.		
Tartar Emetic	$1\frac{1}{2}$ to 2%	$\frac{3}{4}$ to 1%
Mordanting Deep Shade.		
Tannic Acid	3 to 4%	$2\frac{1}{2}$ to 3%
Fixing Deep Shade.		
Tartar Emetic	$2\frac{1}{2}$ to 3%	$1\frac{1}{2}$ to 2%

For dark shades, Tannic Acid may be replaced by cheaper tannin substances, such as Sumach, Divi-Divi, and Myrabollams. Five to six times of the above extracts equal to one pound of Tannic Acid.

Process for Mordanting 100 *lbs. yarn with Katanol ON.*

4 – 6 lbs. Katanol ON
$1\frac{1}{2}$– 2 ,, Soda Ash
20 –30 ,, Glauber Salt
in 120 gallons of water.

Fill the vat 20–30 gallons water, add Soda Ash and bring to the boil. Then sprinkle, whilst stirring vigorously, Katanol ON Powder. When the solution is complete make up the vat to 120 gallons with

cold water. Enter the yarn, give 4 turns, lift up, raise the temperature to 140° F., and the Glauber Salt (previously dissolved), re-enter the yarn and work at 140° F. for $1\frac{1}{2}$ to 2 hours. Then take out and wash thoroughly with fresh water.

	Starting Bath.	Standing Bath.
VIOLET.		
Methyl Violet BB powder ..	$1\frac{3}{4}$ lbs.	1 lb.
Alum	1 ,,	1 ,,
Formic Acid	1 ,,	1 ,,
BLUE.		
Victoria Blue B Highly Conc. ..	13 oz.	Use Fresh Bath.
Alum	2 lbs.	
Formic Acid	1 ,,	
LIGHT GREEN		
Diamond Green GX	3 oz.	
Alum	1 lb.	
Formic Acid	1 ,,	
RHODAMINE.		
Rhodamine B Extra	2 oz.	
Rhodamine 6GDN Extra ..	$\frac{1}{2}$ lb.	
Acetic Acid	1 ,,	
Alum	1 ,,	
ASTRAPHLOXINE. (Very bright pink).		
Astraphloxine FF Extra ..	1 lb.	
Acetic Acid	1 ,,	
Alum	1 ,,	

The Sulphur or Sulphide Colours.

The Sulphur or Sulphide Colours form a class of cotton dyes, which are :—

(1) Insoluble in water, but soluble in Sodium Sulphide,

(2) Oxidisable in air

(3) Very fast to washing, milling, alkalis, acids, cross-dyeing and storing (Sulphur dioxide) and moderately fast to light.

(4) Not resistant to Chlorine, except the Indo-Carbons (Black) which have a certain resistance to Chlorine.

The Sulphur or Sulphide dyes are a class of dye-stuffs, second only to the direct Cotton Colours as regards simplicity, and cost of dyeing, but are in general much faster to washing. They are exyensively used for the production of fast colours on cotton, linen, and other vegetable fibres. The shades in general are rather dull, but like the direct colours, they may be topped with the bright Basic Dyes with, however, some sacrifice of fastness. There are some excellent fast Sulphur Blues, Navy Blues, Brown, Green, and Blacks.

Dyeing Cotton with Sulphur Colours:—

Sulphur Dyes do not dissolve in hot water, but solution is absolutely essential before dyeing can take place. It is found that Sodium Sulphide changes these Dye-stuffs into substances which are soluble in water. They dissolve, therefore, in a solution of Sulphide of Soda, and when so dissolved they dye cotton just like the Direct Cotton Dyes, no previous preparation or mordanting of the yarn or of the cloth being required. The Dye-stuff is dissolved in hot water with the addition of about its own weight of concentrated Sulphide of Soda and Soda Ash, this solution is added to the Dye Bath containing the requisite hot water. The cotton is entered and worked in this bath at or near the boil, and the source of heat immediately withdrawn. Actual Vigorous boiling is undesirable. The dyeing should last three quarters to one hour and the hanks should be turned every few minutes. While so doing, they should not be exposed to the air, but kept under the surface of the liquid (if bent sticks are available, otherwise they can also be dyed just like the ordinary Direct Dyes.

As with the Direct Dyes, the addition of Salt increases the abrorption of Dyes by the cotton so that some salt is always added after the colour has been dissolved, that is the liquor is boiled up, the goods entered, and after a few minutes about 15 pounds of common salt are added. The addition of a little Soda Ash, 3% is also advisable. For example: to dye a medium shade of blue of 100 lbs. of cotton, there should be required about 6 to 8 lbs. of dye-stuff, and 6 to 8 lbs. Sodium Sulphide, one lb. of Soda Ash, mixed with about 10 gallons (100 lbs.) of boiling water added to the dye vat or vessel containing the full quantity of hot water for dyeing, say 200 gallons of solution. The amount of water varies with the material dyed and with the maching used. The minimum quantity consistent with satisfactory handling and working of the goods is used. The dye vat or vessel is usually made of wood with iron

fittings. Cast iron vessels may be used but copper vessels or copper fittings must be absent as these are rapidly attacked by the Sodium Sulphide. The dyed goods do not affect copper when the Sulphide has been washed away. When dyeing is finished, the yarn or cloth should be removed quickly, thoroughly squeezed, quickly rinsed (to prevent unequal development), well shaken in the air, and kept for some time for oxydisation and finally soaped. The resultant dyeings should be sufficient to washing, so that they will withstand many minutes boiling in weak soap solution without alteration in shade, and a piece of white cotton boiled in with them should not be stained.

After-Treatment :—

Although the fasteness to washing and to light of most of these colours is very good, and will satisfy most demands without further treatment, they can nearly all be further improved by after-treatment with metallic salts, such as, Chrome and Copper Salts exactly as described for the Direct Colours. Uusally, the mixture of Bichromate and copper sulphate is used. A treatment with warm solutions of Sodium Peroxide or Hydrogen Peroxide improves the brightness of certain Sulphur Blues, presumably by further oxidation. The treatment is, however, rather expensive, and some times decreases slightly the fastness to washing. The Sulphur Colours can all be mixed with one another and so may be satisfactorily dyed together to give varying colours, so that shade matching has no special difficulties in this respect. A few specially selcted Direct Cotton Colours may also be added for shading purposes, and certain Direct Cotton Yellows are frequently used with Sulphur Colours for shading, these yielding deeper shades, but are not as fast as the Sulphur Yellows. Some of the "Vat" Colours may also be mixed with Sulphur Colours and dyed satisfactorily together. Brighter shades are obtained in dyeing by using "crystal" Sodium Sulphide instead of the "lump", "rock" or "flake" variety, owing to the dark colour always associated with these concentrated varieties. Crystal Sulphide should therefore be used for all light shades and for the brighter Blues, Yellow, Violets and Greens. The Crystals are only half the strength of the concentrated and therefore twice as much must be used, which adds to the cost of dyeing.

Tendering :—

With full shades and blacks, there is some risk of tendering of the goods on storage. This is due to the oxidization of Sulphur to

Sulphuric Acid and is avoided by leaving a little sodium carbonsate or Sodium Acetate in the last washing water after dyeing. This neutralizes any acid which may develop.

Test for Sulphur Colours:—

These are fast ones, but except Indo Carbons are not fast to bleaching. Sulphur Colours can be tested by adding dilute Hydrochloric Acid to the yarn or burnt ash of the yarn, and holding a paper dipped in Lead Acetate solution over it. If the paper is blackened, it is a Sulphur Colour.

Recipes for 100 *lbs. in about* 200 *gallons of liquor* ;—

	I lot	II lot	III & subsequent lots.
BLACK.			
Immedial Carbon BO	10 lbs.	7 lbs.	6 lbs.
Sodium Sulphide	15 ,,	10½ ,,	9 ,,
Soda Ash	10 ,,	2 ,,	2 ,,
Common Salt	20 ,,	5 ,,	5 ,,
BROWN.			
Immedial Yellow Brown 3R ..	10 lbs.	7 lbs.	6 lbs.
Sodium Sulphide Conc. ..	10 ,,	7 ,,	6 ,,
Soda Ash	8 ,,	2 ,,	2 ,,
Common Salt	20 ,,	5 ,,	5 ,,
KHAKI.			
Immedial Khaki OG Extra. ..	2½ lbs.	2 lbs.	2 lbs.
Immedial Black Brown D Extra	¼ ,,	3½ oz.	3½ oz.
Sodium Sulphide Conc. ..	3 ,,	2½ lbs.	2½ lbs.
Soda Ash	2 ,,	2 ,,	2 ,,
Common Salt	5 ,,	3 ,,	3 ,,
GREEN.			
Immediaal Green GG Highly Conc.	8 lbs.	6 lbs.	5 lbs.
Sodium Sulphide Conc. ..	8 ,,	6 ,,	5 ,,
Soda Ash	6 ,,	2 ,,	1½ ,,
Common Salt	20 ,,	5 ,,	5 ,,
BLUE.			
Immedial Direct Blue RL Extra	12 lbs.	8½ lbs.	7 lbs.
Sodium Sulphide	18 ,,	12 ,,	10 ,,
Soda Ash	9 ,,	8 ,,	2 ,
Common Salt	20 ,,	5 ,,	5 ,,

They are usually dissolved at a temperature of 50° C. by reducing the dyestuff with Caustic Soda and Hydrosulphite as with Indigo. The Hydrosulphite forms the so-called leuco-compound of the dyestuff, which has mostly an entirely different shade than the original colours. The Caustic Soda forms the Sodium Salt of this leuco-compound, and only this Sodium Salt is soluble in water. The leuco-compound of the dyestuff has a certain affinity to the cotton fibre. The cotton dyed with this leuco-compound is, avfter completion of the dyeing process, oxydised in the air. By this process, the water insoluble Indanthren Dyestuff re-appears in its original shade.

The dyeing temperature is particularly important. The Indanthrens may be *roughly* divided into cool and hot dyeing colours according to the temperature at which maximum absorption by cotton takes place, i.e. about 30° C. or about 55° C. The best temperature to use for each dyestuff should be found from the Dye Manufacturers' Pattern Cards. Dyes in use for mixture should be selected from the same temperature range.

The Dye Vessel :

This should hold conveniently 200–250 gallons of water for 100 lbs. of yarn, and should be made of wood and not of iron.

Water.

Use good and clean water. The water usually available is hard. Whether water is hard or not, it can easily be ascertained by adding a little soap 15 dwts. for every 4 gallons of water used. If the water becomes cloudy and the soap precipitates, this indicates that the water is hard. Such water should be softened as follows :—

Add a little Soda Ash and Caustic Soda, say about

11	dwts.	6	grs.	Soda Ash,
7	,,	12	,,	Caustic Soda

for every 4 gallons of water taken, and heat the whole. The scum which is thereby formed should be removed. By this process, the water can only be softened down to about 3–4 degrees hardness.

But as some Vat Colours are rather sensitive to hard water, i.e. they are partly precipitated whereby weaker and duller shades are obtained, it is advisable to use a cemical which counteracts the hardness of water. Such c a chemical is for instance Kolepal.

Chemicals:—

(1) Igepon T or Nekal BX for boiling out grey yarn or cloth to remove the impurities, which would otherwise spoil the dye bath and cause uneven and dull shades and also for making the dyestuff powder into a paste.

(2) Caustic Soda and Hydrosulphite for dissolving the dyestuff. This operation is called "reducing the dyestuff."

(3) Levelling Agents: Some of the Indanthren dyestuffs, as Violets, etc., have a great affinity to the cotton fibre and therefore rush on the fibre which causes uneven shades. Peregal O is an Agent which slows the dyeing process down, whereby even shades and better penetration are obtained. In case of hard water, Kolepal may be used.

HOW TO PREPARE YARN OR CLOTH FOR DYEING :—

First way of Boiling.

Grey yarn or cloth contains a lot of impurities which must be removed by boiling out before dyeing. Otherwise, they would prevent the production of even and brilliant shades.

Yarn Boiling.

(1) Pressure Kier Boil must be done with Caustic Soda and/or Igepon T from 8 to 10 hours.

(2) If there is no Kier to boil the yarn in, then steep the material in a Vat containing a bath composed of 2 lbs. of Igepon T and 2 lbs. of Caustic Soda per 100 gallons of water. Next morning give the material a second boil in an open vat and turn the yarn well.

Cloth Boiling.

If the cloth contains starch, it must first be desized with Viveral or Biolase. For this, generally O. 1 to O. 3% (reckoned on the weight of the material) will be sufficient. Prepare the Jiggers (for heavy material) with water of 45 to 50° C. with the desizing chemicals and then enter the cloth. Keep it for 6 to 8 hours and wash after-

wards with hot water and boil the cloth at this stage with Nuva or Igepon T and with a further addition of Caustic Soda or Soda Ash in a pressure Kier for about 10-12 hours. After this process, the cloth should be washed very well, thereafter it will be ready for Bleaching or Dyeing.

The Actual Dyeing Process :—

Vat Dyes must be dissolved with Caustic Soda and Hydro-sulphite, whereby the Colour of almost all of them changes into a very different one, the original colour re-appearing only when all Hydrosulphite has been destroyed by exposing the dyeings to the air or removed by washing.

There are three main processes for dyeing Indanthrens, viz.,

(1) The Hot Process (IN)
(2) The Lukewarm Process (IW)
(3) The Cold Process (IK)

The difference between the three processes is this :

In the Lukewarm and Cold processes less Caustic Soda is used than in the hot process, but an addition of Common Salt or Glauber Salt is made.

The Hot Process is best suited for the following brands :

Brands.		*Colour of the dissolved Dyestuff.*
Indanthren Yellow GF		Olive
,	Rubine R	Greenish Blue
,,	Blue RSN	Same Colour
,,	Brill. Blue RCL	Same Colour
,,	Blue BC	Same Colour
,,	Navy Blue G	Blue
,,	Brill. Violet 4R & 2R	Blue
,,	Brill. Green GG & Olive T	Clear Blue
,,	Olive Green B	Clear Blue
,,	Khaki GGC	,, Red
,,	Dark Blue BO	,, Violet
,,	Direct Black G & RR	Bordeaux
,,	Grey M	Bluish Green.

For dyeing 100 lbs. of yarn according to the above process, the following ingredients are required :—

Water	200 gallons	
Caustic Soda 98% Pdr ..	5 – 6 lbs. for light shades.	
Caustic Soda 98% Pdr. ..	10–12 lbs. for full shades.	
Hydrosulphite	6 – 9 ,,	which is for full shad

shade. For lighter shades, less may be used, but never less than 5 lbs.

For making a powder dyestuff into a paste, a stock solution of 5–8 lbs. Nekal BX or Igepon T per gallon should be prepared. This solution is poured over the dyestuff powder until a smooth paste can be prepared. This paste is diluted with hot water.

Meanwhile, heat the water in the dyevat until it is so hot that you hot that you just can keep your finger in it for a little while. The temperature is now about 120 to 140° F. Now add carefully the Caustic Soda and then in small portions the Hydrosulphite whilst the liquor is gently stirred. Finally add the dyestuff paste straining it through cloth. Now stir the whole gently, and let it stand for about 15 minutes (for complete reduction powder requires at least 20 minutes and paste 10 minutes) Stir up the liquor 3 or 4 times during this time. By that time, the dyestuff will be completely dissolved. This can be recognised by the formation of a "flurry" on the surface of the liquor and by the characteristic colour of the dissolved dyestuff. If light shades are to be dyed *now* an addition of about 1 to 1½ lbs. Peregal O should be made. Then enter the yarn or cloth, dye for about an hour whilst handling the material well at the beginning. Do not let the dye bath cool down. After dyeing, squeeze out the yarn or cloth to remove the water and let it hang in the air for about half an hour or so, untill the colour is developed. Then wash well in cold water. Indanthren Blue gives the finest shade if it is washed immediately after dyeing. In order to fully develop the excellent fastness properties of vast dyes and the brilliancy of the shades, the dyeings should now be soaped for half an hour at the boil with three pounds of soap and three pounds of Soda Ash for every 100 pounds of material. If the available water would be hard and used for soaping as it is, the soap would be decomposed and wasted, and the shade would be rendered dull by the lime soap, which would precipitate and stick to the material. The water must therefore be softened as described above,

or what is more convenient, the soaping should be done not with ordinary soap, but with Igepon T, using 1½ to 3 lbs. for every 100 lbs. of material. Igepon T has a very great advantage in not precipitating even in very hard water. It can also be used in conjunction with ordinary soap to prevent the soap from precipitating. Therefore, it is convenient and further it gives brighter shades.

The Luke Warm (IW) and Cold (IK) Processes are best suited for the following brands :—

Brands	*Colour of the dissolved Dyestuff.*
Indanthren Yellow 3GF (IW)	Olive
,, Golden Orange G (IW)	Magenta
,, Brill. Orange RK (IK)	Reddish Violet
,, Golden Orange 3G (IW)	Yellowish Brown
,, Red FBB (IW)	Brown
,, Brown GG (IW)	Reddish Brown
,, Brown FFR (IW)	Reddish Brown
,, Brown BR (IW) ..	Yellowish Brown
,, Brown R (IW) ..	Reddish Brown
,, Brill. Violet RK (IK)	Reddish Brown
,, Olive 3G (IW) ..	Brown
,, Grey BG (IW) ..	Maroon.

The material required for dyeing 100 lbs. of yarn or cloth are as follows :

Water	200 gallons
Caustic Soda 98% Pdr. ..	6 lbs.
Common Salt	5 to 30 lbs. according to depth of shade.
Hydrosulphite Conc. ..	6 to 9 lbs. This is for full shades, for lighter shades less may be used, but never less than 5 lbs.

Igepon T and Nekal BX: Same quantities as given for Powder brands to be dyed according to hot process.

Dyeing should be carried out in the same way as described for the hot process, namely as follows :—

Make the dyestuff into a paste by pouring over stock solution of Nekal BX or Igepon T and add hot water until the paste is quite thin. Meanwhile, heat the water, but keep the temperature a little lower than the hot process, namely at 110 to 120° F., add the Caustic Soda and then slowly the Hydrosulphite and finally the dyestuff

paste. Again let the whole stand for 15 minutes and then stir gently a few minutes. Then enter the yarn or cloth and dye for about one hour. The dyeing process should be started without Common Salt. The common salt should be added after ¼ hour in order to ensure even dyeings. After dyeing squeeze well or give a short rinsing in water, then let the material hang in the air to let the colour oxydize. Afterwards, wash in water, then soap as described above and wash again.

Note ;—With Indanthren Brilliant Orange RK stronger shades are obtained if the dyestuff is dissolved and the dyeing is carried out at ordinary temperature using, however, twice the quantity of common salt or Glauber Salt as described above for the other dyes.

Special Process.

For Indanthren Pink and Indanthren Magenta :—

Brands ;	*Colour of the Vats.*
Indanthren Pink 3BF	Yellow
Indanthren Magenta B	Yellow

The following are the quantities of Chemicals required to reduce 4 oz. of Indanthren Dyestuff Powder, in separate container, which is called the Stock-Vat. The stock-vat is added to the dye-bath after the colour has properly reduced.

Water	2 gallons
Caustic Soda 98% Powder	8 oz.
Monopol Soap	8 oz.
Hydrosulphite Conc. ..	12 oz.

The Monopol Soap is dissolved in a little hot water and used to make the dyestuff into a thick and uniform paste. Make the water very hot (160 to 180° F.) and add it to the dyestuff paste. Stir the whole thoroughly, then add the Caustic Soda gently and finally, whilst stirring, add the Hydrosulphite. Then let the whole stand for about half an hour. Meanwhile heat the required quantity of water for dyeing, namely 20 gallons to about 100° F. and add a little Caustic Soda and Hydrosulphite. Then add the dyestuff solution, straining it through a cloth. After mixing the whole well, enter the yarn or cloth and dye for about one hour without letting the dye-bath to cool down. After dyeing squeeze well and evenly stretch the yarn or cloth, and let it oxidize in the air. Then wash and soap as described above.

The correct temperature for reducing the dyestuff is as follows:-

For Pink & Magenta (special process) 150 to 160° F.
For Blue (IN) .. .. 130 to 140° Fah.
For Green, Yellow & Violet 110 to 120° ,,
(IN & IW)

Special Process for Indanthren Black BB ;

For dyeing 100 lbs. of material, the following quantities of chemicals and dyes are required.

	Startling Bath.	*Standing Bath.*
Water	200 gallons	
Indanthren Black BB Powder	8½ lbs.	7 lbs.
Caustic Soda 98% Powder ..	20 ,,	5 ,,
Hydrosulphite Conc.	15 ,,	12 ,,

The dyestuff should be made into a uniform paste by pouring it over with a stock solution of Nekal BX or Igepon T as prescribed under the Powder brands of the normal hot process. Meanwhile, heat the water to about 160 to 180° Fah. (for Black), add the Caustic Soda slowly and then in small portions the Hydrosulphite. Now add the dyestuff paste straining it through cloth. Stir the whole and let it stand for half an hour until the colour is fully reduced which can be recognised by the dark violet colour of the vat. Now enter the yarn which should preferably be placed on bent sticks, so that it remains underneath the surface of the liquor and dye for one hour. Then lift the yarn, squeeze it and wash it immediately in water containing a little Hydrosulphite (about 3 oz. per 200 gallons). Then wash well in fresh cold water. The colour of the yarn is a dark green. To develop the shade into Black, the dyeing should be treated for ½ hour in a cold solution of about 1° TW Perchloron (this is a specially strong and stable Bleaching Powder). Afterwards, rinse well in cold water, sour, wash again in water and then soap for half an hour at the boil with 4 oz. soap and 4 oz. Soda Ash for every 100 lbs. of material. Yarn which is used for coloured goods which are bleached afterwards can be used in the green undeveloped state, as it will develop in the bleaching process for the pieces.

Notes ;—

(*a*) When dyeing Indanthren Yellow GF, the quantity of Caustic Soda should be increased by half.

(*b*) Hydrosulphite Conc. will get spoiled by contact with air or moisture, and so it should be carefully covered in a cool dry place. A clean dry spoon should be used for taking out the chemical from the tin.

(*c*) If due to negligence in storing, the Hydrosulphite or the Caustic Soda loses strength, the dyestuff will not dissolve, that is to say, no "flurry" will be formed and the liquor will not assume the characteristic colour of the dissolved dyestuff. If this condition exists, a little more Hydrosulphite should be added, and if this does not help, a little Caustic Soda should be carefully added after it has been dissolved in a little water.

(*d*) If difficulties are experienced in respect of levelling, it is advisable to start dyeing at a low temperature and to heat the bath gradually to the necessary temperature. Further, an addition of 1 to 2 lbs. of Peregal 0 should be made per 200 gallons.

(*e*) The old bath can be used again for dyeing subsequent lots. As a rule, however, it is advisable not to dye more than 4 lots on a standing bath.

Test for Fastness (Indanthren).

Indanthren shades are fast to bleaching. To test them add to the yarn or material a few drops of Caustic Solution and some Hydrosulphite of Soda Powder with some water. The solution will change into different Colours or Shades. If the material under test is reexposed to the air, the original colour will re-appear.

Dyeing Recipes for 100 lbs. Yarn.

		Starting Bath.	*Standing Bath.*
1.	Water	200 gallons	....
	Caustic Soda Powder ..	5 lbs.	2½ lbs.
	Hydrosulphite Conc. ..	7 ,,	6 ,, ,,
	Indanthren Yellow 3GF Pdr.	3 ,,	2 ,, 6 oz.
	Glauber Salt Crystals ..	30 ,,	5 ,,

Dyeing Temperature 120° Fah.

Lukewarm Process (IW)

		Starting Bath.	*Standing Bath.*
2.	Water	200 gallons	....
	Caustic Soda Powder ..	10 lbs.	4 lbs.
	Hydrosulphite Conc. ..	8 ,,	7 ,,
	Indanthren Yellow GF Pdr. Fine	5 ,,	4 ,,

Dyeing Temperature 140° Fah.
Hot Process.

3.	Water	200 gallons	....
	Caustic Soda Powder ..	5 lbs.	2½ lbs.
	Hydrosulphite Conc. ..	7 ,,	6 ,,
	Indanthren Golden Orange 3G Powder	3 ,,	2 ,, 6 oz.
	Glauber Salt Crystals ..	30 ,,	5 ,,

Dyeing Temperature 120°
Lukewarm Process (IW)

4.	Water	200 gallons	....
	Caustic Soda Powder ..	5 lbs.	2½ lbs.
	Hydrosulphite Conc ..	7 ,,	6 ,,
	Indanthren Brilliant Orange RK Powder Fine ..	6 ,,	4½ ,,
	Glauber Salt Crystals ..	80 ,,	10 ,,

Dyeing Temperature – Cold.
Cold Process.

5.	Water	200 gallons	....
	Caustic Soda Powder ..	5 lbs.	2½ lbs.
	Hydrosulphite Conc. ..	7 ,,	6 ,,
	Indanthren Red FBB Powder Fine	3 ,,	2 ,, 6 oz.
	Glauber Salt Crystals ..	30 ,,	5 ,,

Dyeing Temperature 120° Fah.
Lukewarm Process (IW)

6.	Water	200 gallons	....
	Caustic Soda Powder ..	6 lbs.	3 .bs.
	Hydrosulphite Conc. ..	2 ,,	6 ,,
	Hydrosulphite Conc. ..	7 ,,	6 ,,
	Indanthren Brill. Pink R Powder Fine	3 ,,	2 ,,
	Monopol Soal	3 ,,	½ ,,

Dyeing Temperature 140° Fah.
Special Process (Stock Vat).

		Starting Bath.	*Standing Bath.*
7.	Water...	200 gallons	....
	Caustic Soda Powder ..	10 lbs.	4 lbs.
	Hydrosulphite Conc. ..	8 ,,	7 ,,
	Indanthren Magenta B Pdr. Fine	5 ,,	3½ ,,
	Monopol Soap	3 ,,	½ ,,
	Dyeing Temperature 140° Fah. Special Process (Stock Vat).		
8.	Water	200 gallons	....
	Caustic Soda Powder ..	10 lbs.	4 lbs.
	Hydrosulphite Conc. ..	7 ,,	6 ,,
	Indanthren Brilliant Violet 2R Powder	3 ,,	2 lbs. 6 oz.
	Peregal O (in this case especially advisable). ..	1 lb.	4 oz.
	Dyeing Temperature 140° Fah. Hot Process.		
9.	Water	200 gallons	....
	Caustic Soda Powder ..	5 lbs.	2½ lbs.
	Hydrosulphite Conc. ..	7 ,,	6 ,,
	Indanthren Brilliant Violet RK Powder	3 ,,	2¼ ,,
	Glauber Salt Crystals ..	80 ,,	8 ,,
	Dyeing Temperature–Cold. Cold Process.		
10.	Water	200 gallons	....
	Caustic Soda Powder ..	10 lbs.	4 lbs.
	Hydrosulphite Conc. ..	8 ,,	7 ,,
	Indanthren Brilliant Blue RCL Powder Fine	5 ,,	3¾ ,,
	Peregal O (in this case especially advisable)	1 lb.	4 ozs.
	Dyeing Temperature – 140° Fah. Hot Process.		
11.	Water	200 gallons	....
	Caustic Soda Powder ..	22 lbs.	9 lbs.
	Hydrosulphite Conc. ..	15 ,,	11 ,,
	Indanthren Black BB Pdr.	8 ,,	6 ,,
	Dyeing Temperature 175° Fah. Special Process.		

	Starting Bath.	*Standing Bath.*

Dyeing should be treated for half an hour in ½° TW Bleaching solution, and then washed, soured and treated as usual.

12.		
Water	200 gallons	....
Caustic Soda Powder ..	5 lbs.	2½ lbs.
Hydrosulphite Conc. ..	7 ,,	6 ,,
Indanthren Brown GG Pdr...	3 ,,	2 ,, 2 z.
or		
Indanthren Brown FFR Pdr.	3 ,,	2 ,, 2 z.
Glauber Salt Crystals ..	30 ,,	5 ,,

Dyeing Temperature 120° Fah.
Lukewarm Process (IW)

13.		
Water	200 gall ns	....
Caustic Soda Powder ..	5 lbs.	2½ lbs.
Hydrosulphite Conc. ..	6 ,,	5 ,,
Indanthren Grey BG Powder	2 ,,	1½ ,,
Glauber Salt Crystals ..	20 ,,	5 ,,

Dyeing Temperature 120° Fah.
Lukewarm Process (IW)

14.		
Water	200 gallons	....
Caustic Soda Powder ..	10 lbs.	4 lbs.
Hydrosulphite Conc. ..	6 ,,	5 ,,
Indanthren Grey M Powder	2 ,,	1½ ,,
Monopol Soap	1 ,,	2 ozs.

Dyeing Temperature 140° Fah.
Hot Process (IN)

15.		
Water	200 gallons	....
Caustic Soda Powder ..	22 lbs.	9 lbs.
Hydrosulphite Conc. ..	15 ,,	11 ,,
Indanthren Direct Black G Powder Highly Conc. ..	6 ,,	4½ ,,
or		
Indanthren Direct Black RR Powder Highly Conc.	6 ,,	4½ ,,

Dyeing Temperature 175° Fah.
Special Process.

NAPHTOL DYEING.

The different shades of Naphtol AS dyeings are produced by treating the cotton in two successive solutions.

(*a*) Impregnation of the cotton with one of the different Naphtol AS brands, which is dissolved by making it into a paste with Monopol Soap or Eunaphtol AS, and pouring over this paste Caustic Soda and boiling hot water. (This bath looks yellow).

(*b*) Developing the yarn, which is impregnated with the Naphtol Solution, in a fresh bath containing a Fast Colour Salt, which is a stabilized dissotised Base in a form which is water soluble and ready for use.

For obtaining the full fastness and most brilliant shades, the ready developed shades are, after thorough washing, soaped with an addition of Igepon T near the boil.

In Naphtol Dyeing, the following notes are of utmost importance :—

(1) For dissolving the Naphtol, only soft water should be used. If for pasting the Naphtol, Eunaphtol AS is used, the hardness of the water does not play such an important role.

(2) After adding Caustic Soda to the pasted up Naphtol and pouring boiling hot water over the paste, the solution should be quite clear. (If the solution is not clear a short boil is to be given).

(3) Naphtol impregnated material is very sensitive to exposure to light, air and especially acid vapours. To improve the resistance to air before developing (this applies for cases when the Napthtol impregnated yarn cannot at once after impregnation be developed) an addition of Formaldehyde is made, after dissolving of the Naphtol. The impregnated yarn should be covered with cloth which is immersed in the same Naphtol liquor, which is used for impregnating.

(4) Between impregnating and developing, the yarn should be hydroextracted or *very well* squeezed. If the squeezing is insufficient, a shade of very poor fastness to rubbing is obtained.

(5) For obtaining the best fastness to rubbing (which also corresponds to fastness to washing and bleaching) an addition of 1 lb. Diazopon A should be made for 100 lbs. yarn to the developing bath. The Naphtol solution adhering to the yarn brought into the developing bath forms an insoluble colour lacquer, which is precipitating on the yarn and causing unfastness to rubbing. This colour lacquer is kept in suspension by Diazopon A and therefore can be easily washed off in the first cold washing bath after developing.

(6) The developing baths are not stable and therefore cannot be kept for a longer period than one day.

(7) For the protection of the hands from the effect of Caustic Soda in the impregnation baths, rubber gloves should be worn.

For different shades with Naphtol AS, the following combinations are best suited and mostly used :—

YELLOW : Naphtol AS–G/Trivasol Yellow GC

ORANGE : Naphtol AS–OL/Trivasol Orange GC or for a brighter shade.
Naphtol AS–OL/Trivasol Orange RD

RED : Naphtol AS–OL/Trivasol Red RC
Naphtol AS
Naphtol AS–BS/Trivasol Scarlet R.

RED : (With best possible alround fastness.)
Naphtol AS–TR/Trivasol Red TR

CHOLOLATE : Naphtol AS–RO / Trivasol Bordeaux GP
or Naphtol AS–OL

VIOLET : Naphtol AS–TR / Trivasol Violet B

BLUE : Naphtol AS–TR / Trivasol Blue BB *or*
Trivasol Blue RR

BROWN : Naphtol AS–LB / Trivasol Red RC *or*
Trivasol Orange GC.

BLACK : Naphtol AS–SG / Trivasol Red B.

Dyeing Prescriptions for different Naphtols for 100 *lbs. yarn in* 2 *lbs. lots.*

ORANGE : with Napthtol AS–OL / Trivasol Orange RD *or*
Trivasol Orang GC.

In order to ensure economic working, it is advitable to dye at a time a minimum quantity of at least 100 lbs.

A. Impregnation.

It is recommended to work in lots of 2 lbs. of yarn, that is to say, the quantity of 100 lbs. of yarn has to be made up into 50 bundles of 2 lbs. each. The impregnation process requires two baths, namely :

(1) Starting Bath
and (2) Feeding bath.

Prepare the Starting Bath (Naphtolating) as follows :—

Mame 6½ oz. Naphtol AS-OL into a paste with
6 oz. Monopol Soap and some hot water.
Then add 5 oz. Caustic Soda 98% and add further hot water and boil to get a clear solution. Then make upto 4 gallons with cold water. Finally add
2 oz. Formaldehyde 40%

Now the first lot of 2 lbs. yarn is to be impregnated for one minute, but before the next lot of 2 lbs. is entered, the terrine will have to be replenished with feeding liquor, the preparation of which is described hereafter. Then the yarn is to be kept for hydro-extracting.

Feeding Bath for 100 lbs. Yarn.

Take 1 lb. 8 oz. Naphtol AS-OL and make into a
paste with 1 lb. - Monopol Soap and hot water.
Then add 1 lb. - Caustic Soda 98% and further hot water and boil the whole solution till it is clear. Then cool down and make up the whole to 5 gallons in all. Finally add 12 oz. Formaldehyde 40%.

This is the Feeding Bath. For every 2 lbs. of yarn feed the starting bath with 1 lb. of this Feeding Solution, then squeeze well, keep for hydro-extracting and feed again till the whole lot of 100 lbs. has been impregnated.

B. Developing.

Starting Bath for the first lot of 2 lbs. impregnated and hydro-extracted yarn.

Dissolve 12 oz. Trivasol Orange GC or RD
with 4 gallons cold water and add
4 oz. Diazopon A
and 1 lb. Common Salt.

This is the Developing Starting Bath, wherein the first lot of 2 lbs. of yarn has to be developed for one minute. The yarn is to be squeezed well.

Feeding Bath for 100 *lbs. yarn.*

Dissolve 6 lbs. Trivasol Orange GC or RD
and 12 oz. Diazopon A
and 3 lbs. Common Salt with cold water and make upto 5 gallons in all.

This is the Developing Feeding Solution.

For every 2 lbs. of developed yarn, feed the Developing Starting Bath with about 1 lb. of this Feeding Solution.

C. After-Treatment.

Wash the developed and well-squeezed lot of 100 lbs. of yarn in an Hydrochloric Acid Bath containing
1 lb. Hydrochloric Acid
in 200 gallons liquor.

Rinse thoroughly in cold water and soap at boil with
2% Soap,
½% Igepon T,
1½% Soda Ash and
½% Caustic Soda.

Note ;—Igepon T permits the use of *hard* water for the soaping operation.

The impregnation with Naphtol AS–OL for other shades is exactly the same and only the Trivasol (Fast Colour Salt) has to be changed.

For instance, for RED ; (Trivasol Red RC).

For 100 lbs. impregnated yarn: take
12 oz. Trivasol Red RC
and 1 lb. Common Salt
and fill upto 4 gallons with cold water.

For Develloping Feeding Bath for 100 lbs. *yarn.*

Take 6 lbs. Trivasol Red RC
12 ozs. Diazopon A
and 3 lbs. Common Salt
and make up to 5 gallons in all with cold water.

Note ; The method of developing the yarn with Trivasol Red RC is exactly the same as for Trivasol Orange GC or Trivasol Orange RD as explained before.

FOR CHOCOLATE: Naphtol AS–OL / Trivasol Bordeaux GP.

The method of preparing Naphtol AS–OL solution both for Starting and Feeding is exactly the same as for the Orange shade explained before.

Developing; (Starting Bath.)

	12 oz. Trivasol Bordeaux GP
	4 oz. Diazopon A
and	1 lb. Common Salt
made into	4 gallons with cold water.

Developing; (Feeding Bath.)

	6 lbs. Trivasol Bordeaux GP
	12 ozs. Diazopon A
and	3 lbs. Common Salt
made into	5 gallons with cold water.

Note; The method for developing the yarn with Trivasol Bordeaux GP is exactly the same as for Trivasol Orange GC or RD explained in the foregoing.

Also the After-Treatment is done in the same way as for the Orange shade.

RED with Naphtol AS-TR / Trivasol Red TR;

This combination is mostly used for all purposes where a fast red of all round fastness is required.

A. Impregnation.

(1) *Starting Bath;*

5 oz. Naphtol AS–TR

are poured over with a mixture of

7 oz. Spirit,
1 oz. Caustic Soda Powder and
11 oz. Cold Water.

In a short time a clear solution will be obtained. Then add 1½ oz. Formaldehyde
and keep for 5 minutes. The whole is then poured into

4 gallons cold water containing
3½ oz. Caustic Soda and
5 oz. Monopol Soap.

Now the first lot of 2 lbs. of yarn is to be impregnated for a minute, but before the next lot of 2 lbs. yarn is entered for impregnating, the bath will have to be replenished with Feeding Liquor, the preparation of which is described hereafter. The yarn is to be squeezed well and kept for hydro-extracting.

(2) *Feeding Bath* (5 *gallons for* 100 *lbs. yarn*).

1 lb. 8 oz. Naphtol AS-TR

are poured over with a mixture of

2 lbs. 4 oz. Spirit

and 6 oz. Caustic Soda dissolved

in 1 lb. – Cold water.

After obtaining a clear solution, the whole is poured into 5 gallons of cold water containing

1 lb. 2 oz. Caustic Soda Powder

and 1 lb. 8 oz. Monopol Soap.

This is the *Feeding Bath.*

For every 2 lbs. of yarn, feed the Starting Bath with 1 lb. of this Feeding Solution. Then squeeze well, keep for hydro-extracting and feed again till the whole lot of 100 lbs. of yarn have been impregnated.

DEVELOPING ; Starting Bath for the 1*st. lot of* 2 *lbs. yarn.*

Dissolve 12 oz. Trivasol Red TR with cold water

and add 1 lb. Common Salt and make upto

4 gallons in all.

This is the Developing Starting Bath, wherein the first lot of 2 lbs. of yarn has to be developed for one minute. Then the yarn is to be squeezed well.

Feeding Solution for 100 *lbs. of Naphtolated and hydro-extracted yarn.*

Dissolve 6 lbs. Trivasol Red TR with cold water

and add 3 lbs. Common Salt and make upto

5 gallons in all.

This is the Developing Feeding Solution. For every 2 lbs. of developed yarn, feed the Developing Starting Bath with 1 lb. of this solution. Develop every 2 lbs. of yarn for one minute and squeeze well, which operation is repeated till the whole lot of 100 lbs. of yarn has been developed.

After-Treatment is the same as mentioned before.

The impregnation for other shades with Naphtol AS–TR is carried exactly in the same way, and only the Trivasol (Fast Colour Salt) has to be changed according to the shade required.

For instance, for VIOLET. Naphtol AS–TR developed with Trivasol Violet B, take as follows :—

Developing Starting ; (For the first lot of 2 lbs. yarn.)

Dissolve 1 lb. Trivasol Violet B with some cold water
and add 4 oz. Diazopon A
and 1 lb. Common Salt and make upto
4 gallons in all.

Developing Feeding ; (for 100 lbs. of yarn).

Dissolve 8 lbs. Trivasol Violet B with cold water
and add 12 oz. Diazopon A
and 3 lbs. Common Salt and make upto
5 gallons in all.

Note ;—The method for developing the Naphtolated yarn in Starting and Feeding baths of Trivasol Violet B is exactly the same as given before and so also the after-treatment of the dyed shade.

For Dyeing Blue with Naphtol AS–TR/Trivasol Blue BB or Trivasol Blue RR, the process for preparing Naphtol AS–TR solution both for Starting and Feeding Baths is to be done exactly in the same way as for Red. In developing with Trivasol Blue BB or Trivasol Blue RR, do a follows :—

Developing Starting ;

Dissolve 12 oz. Trivasol Blue BB or Trivasol Blue RR with some water and make upto 4 gallons in all. Then
add 4 oz. Diazopon A and
1 lb. Common Salt.

Developing; Feeding ; (For 100 lbs. yarn).

Dissolve 6 lbs. Trivasol Blue BB or Trivasol Blue RR with cold water and make upto 5 gallons in all.
Then add 12 oz. Diazopon A
and 8 lbs. Common Salt.

Note ;—The method of developing the Naphtolated yarn both in the Starting Bath and Feeding Bath is exactly the same as for Red, and so also the after-treatment of the dyed shade.

RED–with Naphtol AS & Naphtol AS-BS/Trivasol Scarlet R.

Naphtolating (Starting Bath).

Take $3\frac{1}{2}$ oz. Naphtol AS-BS
and $3\frac{1}{2}$ oz. Naphtol AS and paste with
7 oz. Monopol Soap and add
7 oz. Caustic Soda 98% (previously dissolved).

Add 10 lbs. boiling water and boil if necessary to get clear solution. Then cool down and add some more cold water to make up to 4 gallons in all.

Naphtolating (Feeding Bath) for 100 lbs. yarn.

Take 12 oz. Naphtol AS–BS
and 12 oz. Naphtol AS and paste with
1 lb. 8 oz. Monopol Soap (previously dissolved)
and add 1 lb. Caustic Soda 98% (previously dissolved)
and add 15 lbs. hot boiling water and boil if necessary to get clear solution. Then make upto 5 gallons in all.

Note ;—Add Formaldehyde after the solution has cooled down, taking half the quantity of the Naphtol used. The Naphtolating of yarn in the above Starting and Feeding Baths is to be done in exactly the same way as is given for Orange shade.

Developing ; Starting Bath for the 1st lot of 2 lbs. yarn.

Dissolve 12 oz. Trivasol Scarlet R with some cold water and make upto 4 gallons in all. Add 4 oz. Diazopon A and 1 lb. Common Salt.

Feeding Bath.

Dissolve 6 lbs. Trivasol Scarlet R with cold water and make upto 5 gallons in all. Add 12 oz. Diazopon A and 3 lbs. Common Salt.

Note ;—The method of developing the Naphtolated yarn in the above Starting & Feeding Baths is to be done exactly in the same way as is given for Orange Shade, and so also the after-treatment of the dyed shade.

CHOCOLATE: *with Naphtol AS-BO / Trivasol Bordeaux GP.*

Naphtolating (Starting Bath).

Make 4½ oz. Naphtol AS–BO into a paste with
4½ oz. Monopol Soap and some hot water.
Then add 4 oz. Caustic Soda 98% and add further hot water and boil to get a clear solution. Then cool down and make upto 4 gallons in all. Finally add
2¼ oz. Formaldehyde 40%

Now the first lot of 2 lbs. yarn is to be impregnated for one minute, but before the next lot of 2 lbs. yarn is entered, the terrine will have to be replenished with feeding liquor, the preparation of which is described hereafter. Then the yarn is to be kept for hydroextracting.

Naphtolating; (Feeding Bath for 100 lbs. yarn).

Make 1 lb. 8 oz. Naphtol AS–BO into a good paste
with 1 lb. Monopol Soap and hot water.
Then add 1 lb. Caustic Soda 98% and further hot water and boil the whole till a clear solution is obtained. Then cool down and make upto 5 gallons in all with cold water. Finally add 12 oz. Formaldehyde 40%.

This is the Naphtolating Feeding Solution.

For every 2 lbs. of yarn feed the Starting Bath with 1 lb. of this Feeding Solution, then squeeze the yarn well, keep for hydro-extracting, and feed again till the whole lot of 100 lbs. yarn has been impregnated thus.

Developing.

Starting Bath.

Dissolve 12 oz Trivasol Bordeaux GP and
4 oz. Diazopon A with some cold water and make upto 4 gallons in all.
and add 1 lb. Common Salt therein.

This is the Developing Starting Bath, wherein the first lot of 2 lbs. of Impregnated and hydro-extracted yarn has to be developed for one minute. Then the yarn is to be squeezed well.

Feeding Bath.

Dissolve 6 lbs. Trivasol Boardeaux GP and
12 oz. Diazopon A with some cold water and make upto 5 gallons in all. Then add 3 lbs. Common Salt therein.

This is the developing Feeding Solution.

For every 2 lbs. of developed yarn, feed the developing starting bath with about 1 lb. of this feeding solution, and repeat till the whole lot of 100 lbs. yarn is developed thus.

The After-treatment is the same as given before.

FAST BLACK with Naphtol AS–SG / Trivasol Red B.

As difficulties are experienced when dyeing Naphtol AS–SG in 2 lbs. lots, it is advisable to *impregnate* Naphtol AS–SG in an *open vat* (ratio of dye to liquor 1 : 20). The Developing process is best carried out in 2 lbs. lots. In order to ensure economic working, it is recommended to dye successively as many lots of 100 lbs. of yarn as possible.

A. Impregnation.

The Impregnation process requires
(1) Starting or Working Bath
and (2) The Feeding Solution.

(1) *Starting Bath* (200 *Gallons*).

There are required :
6 lbs. Naphtol AS–SG
which is poured over with a mixture of

6 lbs. Spirit,
1 lb. 8 oz. cold water,
12 oz. Caustic Soda Powder and
2 lbs. Formaldehyde,

and left for half an hour, whilst stirring. Hereafter a clear solution will be obtained. This solution is added to the dye bath of 200 gallons, containing

5 lbs. 4 oz. Caustic Soda Powder.
2 lbs. Nekal BX and
8 lbs. Dekol.

Now the whole lot of 100 lbs. of yarn is entered and impregnated for ½ hour. Then the yarn is to be squeezed or hydro-extracted.

(2) *Feeding Solution (for* 100 lbs. *yarn):*

There are required

5 lbs. 8 oz. Naphtol AS–SG

to be poured over with a mixture of

5 lbs. 8 oz. Spirit,
8 oz. Caustic Soda Powder,
1 lb. Cold Water and
1 lb. 12 oz. Formaldehyde,

and left for half an hour. Hereafter a clear solution will be obtained. This solution is to be added to

40 lbs. cold water containing
8 oz. Caustic Soda
$2\frac{1}{2}$ oz. Nekal BX and
6 oz. Dekol.

This Feeding Solution is then added to the dye bath. Now enter the second lot of 100 lbs. yarn and impregnate for half an hour.

B. **Developing.**

The Developing of every 2 lbs. of impregnated yarn is to be done at once, after hydro-extracting.

(1) *Starting Bath* (4 *Gallons for* 2 *lbs. yarn.*)

Dissolve

10 oz. Trivasol Red B
2 lbs. Common Salt and
4 oz. Diazopon A

in 4 gallons cold water.

This is the Developing Starting Bath, wherein the first lot of 2 lbs. of yarn is to be developed for one minute. Then the yarn is to be squeezed well.

(2) *Feeding Solution* (5 *gallons for* 100 *lbs.*)

Dissolve

6 lbs. 11 oz. Trivasol Red B,
2 lbs. 8 oz. Common Salt

and 12 oz. Diazopon A

in 5 gallons cold water.

This is the Developing Feeding Solution. For every 2 lbs. of developed yarn, fed the Developing Starting Bath with 1 lb. of this Feeding Solution. Develop every 2 lbs. of yarn for one minute and squeeze well, which operation is to be repeated till the whole lot of 100 lbs. of yarn has been developed.

C. After-Treatment.

Same as prescribed before.

FAST BROWN with Naphtol AS–LB/Trivasol Orange GC or Trivasol Red RC.

In order to ensure economic working, it is advisable to dye at a time a minimum quantity of at least 100 lbs.

A. Impregnation.

It is recommended to work in lots of 2 lbs. of yarn in the terrine. The Impregnation process requires two baths, viz,

(1) The Starting or Working Bath
and (2) The Feeding Bath.

(1) *Starting or Working Bath ;*

4–1/3 oz. Naphtol AS–LB are made into
a paste with 4 oz. Monopol Soap and
2 oz. Caustic Soda Powder dissolved in
3 oz. Water.
This paste is poured over with
3 lbs. Boiling water.
After a few minutes a clear solution will be obtained.

This solution is added to
$3\frac{1}{2}$ gallons cold water containing
$2\frac{1}{2}$ oz. Caustic Soda Powder.

This is the Impregnating Starting Bath, in which the first lot of 2 lbs. of yarn is impregnated for one minute, but before the next lot is entered, the terrine will have to be replenished with Feeding Liquor, the preparation of which is described hereafter. Then the yarn is to be squeezed well and kept for hydro-extracting.

(2) *Feeding Solution* (*5 gallons for* 100 *lbs. yarn*).

3 lbs. $4\frac{1}{2}$ oz. Naphtol AS–LB are made into
a paste with 3 lbs. Monopol Soap and
13 oz. Caustic Soda Powder.
This paste is poured over with
35 lbs. Boiling water.

This solution will be clear after a few minutes and is then diluted with

1 gallon cold water, containing
11 oz. Caustic Soda Powder.

This is the Impregnating Feeding Solution. For every 2 lbs. of yarn feed the working bath with one lb. of this Feeding Solution. Then squeeze well, keep for hydro-extracting and feed again till the whole lot of 100 lbs. of yarn have been impregnated.

B. **Developing;** (in 2 lbs. lots).

The developing of every two lbs. of impregnated yarn has to be done at once after hydro-extracting.

(1) *Starting Bath (4 gallons for 2 lbs.)*

Dissolve

11 oz. Trivasol Red RC or
Trivasol Orange GC
2 lbs. Common Salt and
4 oz. Diazopon A
in 4 gallons cold water.

This is the Developing Starting Bath, wherein the first lot of 2 lbs. of yarn has to be developed for one minute. Then the yarn is to be squeezed well.

(2) *Feeding Solution (5 gallons for 100 lbs.)*

Dissolve

7 lbs. 4½ oz. Trivasol Red RC or
5 lbs. Trivasol Orange GC
2 lbs. 8 oz. Common Salt and
12 oz. Diazopon A
in 5 gallons cold water.

This is the Developing Feeding Solution. For every 2 lbs. of developed yarn, feed the Developing Starting Bath with 1 lb. of this Feeding Solution. Develop every 2 lbs. of yarn for one minute and squeeze well, which operation is to be repeated till the whole lot of 100 lbs. of yarn has been developed.

C. After-Treatment:

As before.

YELLOW – with Naphtol AS–G / Trivasol Yellow GC.

Naphtolating ; (Starting Bath).

Dissolve 6 oz. Naphtol AS–G with
3 oz. Monopol Soap and Hot water
and add 3 oz. Caustic Soda 98% and
boil the whole to get a clear solution. Then cool down and make upto 4 gallons in all.

Impregnate the first lot of 2 lbs. yarn in this solution for one minute, but before the next lot of 2 lbs. of yarn is entered, the terrine will have to be replenished with feeding liquor, the preparation of which is described hereafter. Then the yarn is to be kept for hydroextracting.

Naphtolating; (Feeding Bath).

Dissolve 1 lb. 5 oz. Naphtol AS–G with
11 oz. Monopol Soap and
some hot water. Then add 10 oz. Caustic Soda 98% and add some more hot water and boil the whole to get a clear solution. Then cool down and make upto 4 gallons with further cold water.

This is the Feeding Bath. For every 2 lbs. of yarn feed the Starting Bath with 1 lb. of this Feeding Solution then squeeze well, keep for hydroextracting and feed again till the whole lot of 100 lbs. of yarn has been impregnated thus.

Developing:—(Starting Bath).

Dissolve 12 oz. Trivasol Yellow GC with cold water and make upto 4 gallons in all.

Then add 12 oz. Common Salt therein and
further 3 oz. Acid Acetic Conc.

This is the Developing Starting Bath, wherein the first lot of 2 lbs. yarn has to be developed for one minute. Then the yarn is to be squeezed well.

Developing Feeding ; (For 100 *lbs. yarn).*

Dissolve 6 lbs. Trivasol Yellow GC with some cold water and make upto 5 gallons in all.

Then add 3 lbs. Common Salt therein.

This is the Feeding Bath. For every 2 lbs. of yarn feed the Starting Bath with 1 lb. of this feeding liquor and develop the next lot of 2 lbs. yarn therein. Then squeeze well and repeat this method till the whole lot of 100 lbs. of yarn has been developed thus.

Note ;—No Formaldehyde should be added to any of the Naphtol AS–G solution as the resistance to air of the Naphtol AS–G impregnated yarn is entirely satisfactory; besides, Formaldehyde is not agreeable to the Naphtol AS–G solution.

After-Treatment.

Wash the developed and well-squeezed lot of 100 lbs. of yarn in an Hydrochloric Acid Bath containing

1 lb. Hydrochloric Acid
in 200 gallons liquor.

Rinse thoroughly in cold water and soap at boil with

2% Soap,
½% Igepon T
1½% Soda Ash and
½% Caustic Soda.

Note ;—Igepon T permits the use of *hard* water for the soaping operation.

Mechanical Dyeing of Cheeses & Beams.

Recently the mechanical dyeing of yarn in the shape of cheeses and beams has been introduced in the Textile Mills of this country and this process is getting more and more popular in the Textile Mills on account of the special advantages accrueing from the same. It would therefore be worthwhile to discuss in brief this new process which is bound to find favour with the Textile Industry, on account of the increased internal competition and the race for reduction of manufacturing costs.

When compared with the dyeing of yarn in the form of hanks in wooden vats as practised formerly, the dyeing of yarn in the form of cheeses is found to be more economical since it helps in effecting

savings in wages, steam, dyestuffs, chemicals and waste. The savings in wages are very obvious since the tedious and expensive operation of reeling into hanks and re-winding from hanks to warpers' bobbins is dispensed with. Besides, the proportion of the dye bath to the material to be dyed is more favourable in mechanical dyeing, thus helping in reducing the cost of colours and chemicals to a certain extent. Another special feature of Cheese & Beam Dyeing is the gentle treatment and soft handling of the yarn during the process of mechanical dyeing when compared with the hank dyeing where the hanks are treated more roughly and result in higher percentage of waste. At the same time, the dyeing operation is put on a scientific basis and there is no more any risk about the effects in dyeing resulting from the human element.

The following comparison about the process employed in hank dyeing and for mechanical dyeing of Cheeses will be found interesting :—

1. *Hank Dyeing ;* The process consists of:
   a. Reeling of yarn into hanks,
   b. Dyeing of hank yarn
   c. Winding the hank yarn on the colour winding machine.

2. *Mechanical Dyeing of Cheses ;* The process consists of:
   a. Winding of yarn into cheeses on high speed windermachine
   b. Dyeing cheeses.

The question whether one should dye yarn in the form of cheeses, cones or beams has to be decided in relation to the local conditions and requirements of the Mills. It is also sometimes found necessary to dye in the shape of loose cotton or card slivers or roving bobbins with a view to meet the particular demands of manufacturing certain kind of fabrics. It is therefore advisable to use a plant which has an arrangement for dyeing cheeses and beams and also loose cotton or card slivers. It is common Mills experience that the requirements of the dyeing shed fluctuate with the fluctuating demands of the cloth market and therefore provision should be always available for mechanical dyeing in any desired form or shape. It is a great advantage and achievement in the construction of the dyeing plant that all the modern plants are constructed on the universal principle so that it is possible to dye yarn or cotton in any desired form.

The technical outfit of a modern cheese and beam dyeing plant consists of the following machines :—

1. Boiling machine
2. Universal dyeing machine
3. After-treatment machine.

The dyeing process is roughly as follows :—

The cheeses that are wound on perforated tubes are put on a material carrier and the material carrier with the cheeses is first put into a boiling apparatus where cheeses are boiled for about 40 minutes adding Igepon T. Afterwards the material carrier is taken out and put on the suction table where cheeses are sucked by vacuum plant. Subsequently the carrier is put in a dyeing apparatus with necessary quantity of Caustic Soda, Hydrosulphite and Kolepal but without the dyestuffs in the beginning. In the meantime, the dye liquor is prepared and is added in 3 to 4 instalments in the special addition tank of the dyeing machine. During the process of dyeing, it is advisable to reverse the direct;on of circulation from inside to outside and from outside to inside every 2 or 3 minutes, and later on every 5 to 8 minutes. After all the instalments of the dye liquor have been put in, the temperature can be raised slowly, but in no case should rise of temperature coincide with the adding of the dye liquor. The dyeing time is about 40/50 minutes, according to the nature of the shade. When the dyeing is over, the material carrier is taken out and oxydised on the suction table and subsequently the same is rinsed and soaped in the after-treatment machine preferably with the help of Igepon T.

It is necessary to keep in mind certain special points for obtaining the required good results with the cheese and beam dyeing plant.

Re; Water ; The water employed for dyeing process should be 0° hardness, particularly for dyeing Indanthren colours. While dyeing with hard water, the lime salts contained therein would precipitate when Caustic Soda is mixed with it with the result that the dye liquor cannot penetrate the yarn on account of the salts producing a sort of coating on the yarn. However, this question would not be so important in case of dyeing cheeses with direct colours. It should be remembered that whereas soft water is essential for Indanthren shades, hard water can be utilised for auxiliary processes of boiling and after-treatment. Use of Igepon T in such cases would help in getting better results.

In most cases, the textile Mills employ well water which has temporary hardness and this can be removed by boiling. As an alternative the Mills can utilise the condensed water available from Sizing and Finishing macnhines at the Mills.

If only hard water is available, an addition of about 4 lbs. Kolepal to 400 gallons dye liquor previous to the addition of Caustic Soda, Hydrosulphite and dyestuff prevents the precipitation of lime salts and renders thereby the shades brighter and fuller and also ensures even dyeing.

2. *Dyestuffs;* It is necessary to give special attention to proper selection of the dyestuffs. The dyestuff should be in specially fine powder so that it can be completely dissolved while preparing the dye bath. It is quite possible to dye any desired shade on cheeses or beams although it should be mentioned that certain dyestuffs which are a little difficult in levelling require the use of a levelling agent. It is advisable always to start the dyeing process with a low temperature and raise it slowly.

The following recipe for light violet shade will be found interesting:

264 lbs. of cheeses made from 48s single yarn in 400 gallons liquor
15 ozs. Indanthren Brill. Violet RR Pdr. Fine
5 lbs. Kolepal
10 lbs. Hydrosulphite
16 lbs. Caustic Soda.

3. *Winding and Warping;* It is also necessary to arrange for uniform winding of cheeses and beams. They should have no soft and hard places and the winding should be uniformly soft or uniformly hard. Warping of beams for mechanical dyeing can be arranged very easily by making some adjustments on the ordinary type of warping machines.

Determination of Cotton Dyestuffs on the Fibre.

Absolutely fast colours are not yet produced, and, when testing any coloured fabric, the purpose for which the cloth is intended should be known, so that tests can be made accordingly.

"Basic" Colours fairly fast to light.

"Sulphur" colours are good washing colours, mostly fast to light but not to bleaching.

"Indanthrenes" dyestuffs are supposed to be the fastest colours to light and bleaching.

Fastness to Water.

The dyed fabric may be folded together with a white cloth and boiled in distilled water for 10 to 15 minutes. The bleeding of the colour is noted.

Fastness to Washing.

Fold together a strip of the coloured cloth with a similar strip of white cloth, and steep for 15 minutes in a half per cent. solution of soap and sodium carbonate at 50 dgrees C.; during this period squeeze ten times. Remove the twisted strips from the alkaline soap liquor, and without rinsing, place between two white tiles and press with a heavy weight for about 15 minutes; then remove the weight and examine for marking off the dye on the white fabric. Then rinse in cold water and dry. Observe the tint of the white strip and the loss of colour of the coloured material. Repeat this test (excluding the pressing) three or four times with drying between each test. The tint of the white fabric and the loss of shade of the material being tested will indicate its fastness to houeshold washing and not the merciless Dobby Washing. See also under Questions and Answers.

Boiling Test.

Take about 20 threads 1 to $1\frac{1}{2}''$ each of the dyed yarn to be tested and tie them together with 10 equally long threads of bleached cotton yarn of a similar count. If the pattern is very small, 5 to 6 threads with exactly half the quantity of white will be sufficient. In the case of a piece of fabric, a cutting $\frac{1}{4}''$ square with half the size of the material will do.

The pattern thus prepared is put into a test tubes, about 3 cc. of a soap—soda solution containing 3 grammes soda ash and 5 grammes Marseilles soap per litre is added, and the whole boiled cautiously over the Bunsen burner with a screwed down flame for 30 minutes. Cool in a bath at 40°c for 30 minutes. Care must be taken that the liquor does not evaporate completely or squirt out. Afterwards the contents of the test tube are poured into cold water, the pattern well washed and dried. Compare with original.

According to the aspect of the white material boiled together with the pattern, the result of this boiling test allows the following conclusions :—

(1) If the dyeing to be tested and the white piece boiled with it are dyed approximately the same depth, the product is a direct dyestuff dyed in the ordinary way.

(2) If the white has only been stained at ¼ the depth of the pattern, the material is dyed with diazotized or after treated direct dyestuff.

(3) If the dyeing has lost in depth considerably, or even been destroyed partly or totally, and if the white material could be rinsed perfectly clean again in cold rinsing water, basic or acid dye-stuffs were used for the production of dyeing.

(4) If the white material has been stained so slightly that it is doubtful whether the product is a particularly fast diazo dyestuff, or an inferior sulphur dyestuff, the same pattern which has been used for the boiling test is tested further as follows :—

A little Hydeosulphite conc. powder is dissolved with water in a test tube, the solution made alkaline, heated up, and then the small pattern thrown in. If a reduction of the dye-stuff occurs, which is noticeable at least by a distinct change of shade, and if the original shade is restored by a subsequent rinsing in cold water, the product in question is a sulphur dyestuff. If, on the other hand, the original shade is permanently changed or partly or totally destroyed by the reduction, the product in question was a fast diazo dyestuff.

(5) If the white material has not been changed at all by the boiling test, the pattern is dyed with a vat, sulphur or mordant dyestuff. A small piece of the material to be tested is heated for further testing for a little while in the test tube with a few drops of a solution of 100 grammes staunsus chloride in 150cc. hydrochloric acid 20%, then the test tube is covered with damp lead paper and heated further. A blackening indicates the presence of a sulphur dyestuff. If the paper is left clean, there only remains to distinguish between vat and mordant dyestuffs. Of the latter ones Alizarine will chiefly occur.

Speciai Test for Red on Cotton.

A boiling test as described on the previous pages is first carried out to ascertain whether the product in question is a direct, diazotized, after treated, basic or Resorcine dyestuff.

If the red has not lost in shade, and if the white material been left clean, a distinction can only be made between Turkey Red, Vat red and Naphtol AS or Para Red.

Para Red can be detected by burning a piece of the sample and squeezed between two sheets white paper, when the paper is stained red. Other reds do not mark off.

Tests for Turkey Red.

A single thread about 1" long is put into a dry test tube and not more than 7-8 drops concentrated sulphuric acid poured on to it. Wait for a short time until the thread is completely dissolved. Then ½ cc. of water is carefully added; if the solution is thereby changed to a clear light yellow, this change of colour alone indicates with certainty Alizarine. To be quite sure, the solution is cooled down and carefully mixed with a slight excess of ammonia. According to the size of the pattern, a more or less strong, but distinct violet coloration confirms the presence of Alizarine.

Spot the sample with nitric acid, and it turns yellow if alizarine. Alizarine red turns a violet colour when treated with a solution of caustic soda. Turkey red turns violet when treated with ammonia.

Test for Vat Red Naphtol AS and Para Red.

A piece of the dyed thread to be tested is reduced in a hot solution of Hydrosulphite and Caustic Soda. If the shade is changed but returns if exposed to air, the yarn has been dyed with a vat dyestuff. If the shade does not return and the thread remains white, it is a Para Red dyeing. If the fibre however, is tinted a faint yellow, the thread was dyed with Naphtol AS. As a control a sublimation test is recommended. Para Red Sublimates, Naphtol AS not.

Test for Direct Colour.

Congo Red, Chrysophinine etc. These colours bleed and when boiled in dilute solution the latter becomes coloured. If a piece of white cotton is heated in the solution it takes up the colour and remains dyed. Congo red turns violet or very deep blue with a drop of Hydrochloric or Sulphuric acid (diluted). These are not Fast to Bleachiug.

Hydrosulphite solution removes the direct colours entirely on boiling. Some of the darker shades need longer boiling.

Primuline Red is a developed class of dye, fast to washing and will stand a boiling water test.

Treated in a hydrochloric solution, the colour changes to yellow. On washing these threads and treating in a cold solution of sodium nitrate, to which is added a few drops of hydrochloric acid, washing again and treating with a solution of B Naphtol in caustic soda, the red colours returns if primuline.

Basic Colours.

Methy violet, Brilliant green, Rhodamine give very bright shades on cotton even in small percentages when treated with dilute caustic soda, the shades fade away and are destroyed. Logwood Black turns red, on spotting with hydrochloric acid.

Sulphur Colours.

These are fast ones and except Indo carbon C.L. Conc. are not fast to Bleaching. Sulphur colours can be tested by adding dilute Hydrochloric acid to the yarn or burnt ash of the yarn and holding a paper dipped in lead acetate solution over it. If the paper is blackened it is a sulphur colour.

Sulphur Black, boiled in a solution of hydrosulphite, turns brownish, but the colour returns on exposure to air.

Special Test for Indigo on Cotton.

The following tests indicate the presence of Indigo.

(*a*) 'Spotting test'—Spotting with concentrated nitric acid destroys Indigo dyeings, leaving a yellow stain with greenish edges or rim. If there is no green rim the dye is not indigo. Some acid, basic, and alizatine blues give a yellow spot only.

(*b*) Sublimation test—A small piece of the dyeing is lit and immediately squeezed between two sheets of white paper. Light Blue stains indicate Sublimated Indigo.

(*c*) Indigo resists boiling with water very well. Boil a few threads in a solution of hydrosulphite in a test tube, and the blue colour can be seen to turn yellow, but if indigo, the original colour returns on exposure to air.

(*d*) Cotton dyed with indigo blue gives off a purple vapour when burned, which condenses on a cold surface, giving a blue stain.

(*e*) Place a small sample in chloroform, and the solution turns blue if indigo is there, but is unchanged if not indigo.

Special Test for Black on Cotton.

To ascertain the nature of a black dyeing, the pattern is first of all subjected to the boiling test as described above, in order to find out whether it has been produced with a substantive black dyed direct, diazotized or after treated.

If the white material has come out clean from the boiling test, a small piece of the black dyeing is heated in the test tube with not too weak a solution of calcium hypochlorite or sodium hypochlorite. If the black is completely discoloured, it is a sulphur black. If the black changes to a reddish brown without discolouring, it is an aniline black.

The presence of Logwood Black is indicated by moistening the pattern with a little hydrochloric acid and squeezing it between filter paper. A reddening of the filter paper indicates the presence of logwood.

Vat Colours.

Indanthrenes and Caledons are fast to bleaching shades. To test them add to the yarn a few drops of caustic soda solution and some Hydro Sulphide of soda powder with some water. The solution will turn into a different colour. If we take out the yarn and expose it to air the original colour of the yarn will be resumed.

All bright Red and Maroon shades not belonging to the above groups are Naphtol combination fast to bleaching.

"Tests to be applied to determine fastness of Coloured Borders and Headings."

(*a*) "*Presence of Basic Dyes on Alizarine.*"

Treat a small portion of the coloured border or heading with acetic acid, and press between white blotting paper. If any basic colour has been used, a distinct colouration will be apparent on the blotting paper.

(*b*) "*Presence of Direct Black.*"

Treat the coloured border or heading with a strong solution of bleaching liquor. If direct black has been used it is identified by the formation of a heavy buff stain. If the colour be a pure aniline black the strong bleaching liquor changes it but slightly, forming a greenish black.

(*c*) "*Presence of Logwood Dye.*"

Treat a portion of the coloured border or heading with hydrochloric acid, a bright red stain indicates logwood.

(*d*) "*Presence of Direct Blue on Indigo.*"

Should a portion of coloured border or heading be treated with nitric acid, it will discharge the indigo, leaving a buff stain surrounded by a green colouration. If this test be carefully watched, any

direct blue which may be present is detected by the appearance of a reddish stain. This stain takes longer to discharge than pure indigo. Should the red stain appear, treat another portion of the dyed border with a weak solution of bleaching powder. This will discharge the direct colour, leaving the indigo. If this portion be then well washed and treated with nitric acid, the indigo will be discharged, without the production of the reddish stain.

(*e*) "*Presence for Orange Chrome and yellow Chrome.*"

Treat the orange or yellow border or heading with dilute hydrochloric acid. The colours rapidly disappear, the orange passing through various shades of yellow, until st is entirely discharged, whil- the yellow is rapidly destroyed. In each case a colourless substance, chloride of lead, is found. The presence of the lead salt may be determined by adding to the discharged portion of the border or heading a few drops of a solution of sulphuretted hydrogen, or sulphide of ammonium. A black stain is produced if lead be present.

"*Tests for Acids*"—While determining faults in cloth—Place a piece of wet blue litmus paper on the cloth and fold the cloth over, so that the litmus paper comes in contact with the part to be tested on both back and front. Place a piece of clean white paper over the cloth, and press the whole together by placing a weight on the top of this. If the colour of the litmus paper be changed to a bright red, acid is present and its nature should be ascertained.

Fastness to Acids.

The dyed material is immersed for some time in a 5 per cent. solution of acetic acid or a weak solution of hydrochloric or sulphuric acid (say 1/10th per cent. Sulphuric or Hydrochloric acid solution). Dyed goods when so treated should show no bleeding

Fastness to Ironing and Steaming.

In order to ascertain the fastness to ironing and steaming, the pattern may be placed between sheets of filter paper pressed with a heated flat iron. The bleeding if any should be noted.

The indications may be classed as follows :—

(i) Colour strongly changed and bleeds on to white filter paper.

(ii) Colour slightly changed, no bleeding on to white filter paper.

(iii) Colour not changed, no bleeding on to white filter paper

Fastness to Friction and Rubbing.

The dyed fabric is rubbed on a piece of white calico or on a sheet of a white paper. The bleeding should be noted. Indenthrenes (vat colours) and mineral khaki are the best towards friction and rubbing and so are, to a lesser degree, azoic, naphtols and sulphur colours. Basic colours are as a rule very bad towards rubbing and these should be avoided where the fabric has to stand much wear and friction.

Fastness to Perspirations.

A perspiration test is based on the fact that human perspiration is acidic but capable of becoming alkaline through decomposition of its nitrogenous constituents, and that it contains chlorine as chloride.

The dyed material is impregnated with a solution containing 1 per cent. of sodium chloride and 0.1 per cent of acetic acid, then allowed to air dry, and the change of colour observed. Afterwards, another sample of the fabric should be impregnated with a similar salt solution containing 0.1 per cent. of ammonia instead of acetic acid, dried, and the colour changes observed. It may be desirable to twist the coloured fabric with white fabric in these tests in order to observe the bleeding such as may occur when garments are worn.

(*a*) If colour fades and stains the white cloth it is poor.
(*b*) If colour does not fade but stains the white cloth it is fair.
(*c*) If colour and cloth remain unaffected it is good.

As some perspirations are acid and others alkaline, so both tests should be made.

Fastness to Sunlight.

The fading of a coloured fabric in sunlight is dependent on

(*a*) the intensity of the light, (*b*) the temperature of the fabric, (*c*) the wave length of the incident light (*d*) the humidity of the surrounding air.

As a rule the red, yellow, brown, and black dyestuffs surpass the green, blue, and violet dyes. Many of the acid and substantive dyes are moderately fast to light, whereas the basic dyes are, on the whole, fugitive. Indanthrenes dyestuffs are supposed to be the fastest colours to light and fabrics which have to stand long expo-

sure to light are usually dyed with these dyestuffs. The method followed for testing for fastness to light is as follows :—

The dyed pattern is tightly fixed in a metal frame and partly covered with black paper and expossed under glass to the action of sunlight for a number of hours depending upon the class of dyestuffs used. Fading due to sunrays is then noted.

Dyeing and Bleaching Machinery.

Dyeing and bleaching machinery are individually driven to a much greater extent for their scattered lay out, lack of uniformity in machines. Only the number of Jiggers out of the whole lot to be driven in a group system. The number of motors required for this department are as follows :—

1.35 B.H.P. Bleaching motor, 2.6 B.H.P. Kier motor, 1.30 B.H.P. Electroliser motor, 1.8 B.H.P. Drying cylinder, 1.15 B.H.P. motor for 20 Jiggers, 1.75 B.H.P. for 7 Bowl calender 1.55 B.H.P. for 3 Bowl Calender 2.5 B.H.P. for 2 stenters, 1.20 B.H.P. for folding and baling press, 1.6 B.H.P. Hydro extractor, 1.10 B.H.P. Mordanting machines.

Piece Goods Stamping Machine.

I.H.P. = $\frac{1}{4}$
Speed of Machine = 115 R.P.M.
Production = 900 to 1500 full size pieces per hour or
2000 to 3000 Dhoties per hour.

Size of machine = 60″ × 20″ or 36″ × 20″ or any size that may be required

Rayon or Artificial Silk.

Rayon is a lustrous fibre, produced by pressing cellulose or a cellulose derivation which has been dissolved by special processes, through capillary tubes, and causing the fine stream of solution obtained in this way to become quickly coagulated to threads.

There are four main types of Rayons. :—

1. Viscose Rayon
2. Cuprammonium Rayon
3. Nitrate Rayon
4. Acetate Silk.

The first three kinds of rayon all of which in the process for manufacture in the final state are composed of pure cellulose. In their dyeing properties they are closely related to each other and to cotton. Acetate silk does not represent cellulose as such, but is cellulose-acetic-acid-ester i.e. cellulose acetate. Hence it totally differs in its tinctorial properties from the above three kinds of rayon and has to be dyed with special colours such as Duranols, Dispersols,

Cleaning or Scouring Prior to Dyeing.

Rayon yarn contains a lot of oil, fat and different kinds of waxes, used in the sizing mixtures applied to the yarn in its final manufacturing state. All these should be thoroughly removed from the fibre before dyeing. Generally a thorough scouring is obtained by treating the rayon for ½ hour at 160°–170°F., in a bath containing

2–3 lbs. Soap
½–1 lb. Lissapol T
& ½–1 lb. Astol A per 100 gallons of water.

If only hard water is available it should be treated with

1–2 lbs. Lissapol T
½–1 lb. Perminal KB
1–2 lbs. Soda Ash
per 100 gallons of hard water.

The above treatment is also given to the rayon pieces. But sometimes it has been observed that the warps in the pieces are sized with starchy substances. In such cases, the rayon cloth is worked in a bath containing

0.2–0.5% Polyzime N

for a few minutes and then left piled up in wet condition for some hours. Afterwards it is washed and scoured as stated above with soap and Lissapol.

Rayon pieces, the warps of which are sized with waxes, both natural or artificial and animal & vegetable fats should be thoroughly desized with Astol A in order to prevent patchy dyeing.

Acetate Silk is washed with

$\frac{1}{2}$-1% Lissapol T, at 160°-175°F., for $\frac{1}{2}$ hour.

While treating acetate silk, an addition of Soda Ash or Caustic Soda to the washing bath should be omitted, as the saponification of cellulose-acetate takes place thus impairing its properties and lustre.

Rayon Bleaching.

Rayon, as it is sold in the market, comes in a fairly white condition. Only for the production of particularly bright shades on Rayon yarn and full white effect on cloth it is subjected to the bleaching treatment.

For bleaching, Sodium Hypochlorite solution is found to be the best, as the use of the solution of bleaching powder sometimes causes the dulling effect due to the traces of calcium salts left on the fibre through insufficient washing and souring treatments.

The rayon yarn, cleaned as described above, is treated for $\frac{3}{4}$-1 hour in a cold bath of Sodium Hypochlorite containing

$1\frac{1}{2}$-2 lbs. available chlorine per 100 gallons,

rinsed, acidified cold in a bath containing $1\frac{1}{2}$ pint Hydrochloric Acid Conc. per 100 gallons, washed and soaped at 140-160°F and finally washed. Alternatively it may be bleached with a solution of bleaching powder containing $1\frac{1}{2}$-2 lbs. available chlorine per 100 gallons bleaching liquor and then aftertreated as stated above.

A short aftertreatment with Hydrosulphite enhances the bleaching effect, while Hydrosulphite itself acts as antichlor.

For this purpose, the rayon yarn after taking it out through the bleaching liquor, is washed and treated for 15-20 minutes in a warm bath containing 1-2 lbs. Hydrosulphite Conc. per 100 gallons. It is then washed, soured, washed and soaped as above.

The rayon pieces may be treated as above, but a combined chlorine-peroxide bleach is found to be the best, especially in the case of mixed fabrics containing rayon and cotton.

The rayon cloth is desized as described above and then treated in a bleaching liquor containing 1–1½lbs. available chlorine per 100 gallons. After rinsing, the cloth is entered into a bath prepared with 1 lb. Hydrogen Peroxide 40%, 1 lb. Silicate of Soda, ½ lb. Caustic Soda flakes and ½ lb. Lissapol T per 100 gallons. The temperature of the bath is gradually raised to 140°F and the cloth is worked at this temperature for 1–2 hours more, rinsed well and soaped, and finished as usual.

The use of detergents, such as Lissapol in the bleaching liquor enhances the bleaching effect and at the same time imparts to the cloth a soft supple handle.

Blueing in the usual manner is done by using, Solway Blues or Purples and Soluble Blues, in the soap or finishing baths.

Practical Hints on the Dyeing of Rayon.

Rayon, a very delicate fibre, loses its tensile strength in the wet condition and particular care must therefore be exercised in handling it.

Hanks are opened out on smooth sticks, carefully straightening under the lea-bands. Sticks made of ebonite, stainless steel or monel metal or glass have proved very useful. Ordinary wooden or bamboo sticks are very rough and on constant use become very splintery. This causes the breakage and entanglement of threads and consequent difficulties in winding and reeling. It is also imperative that the walls of the dye-vessels should be very smooth. The wooden vessels should be lined with porcelain tiles or sheets of monel metal. Copper vessels can be used, but the use of such vessels should be avoided whilst dyeing sulphur or vat colours.

Particular care must be taken while hydroextracting. Each hank should be carefully packed in cloth before putting it in the Hydro-extractor. After hydroextraction the hanks are opened out and carefully straightened on poles in a moist condition. The drying temperature should not exceed 140°F., as when dried at too high a temperature, the rayon is liable to become hard and brittle.

In view of the tenderness of rayon when in a moist condition, it cannot be dyed on the usual cotton jigs, as it is apt to tear. Rayon cloth therefore may be dyed on tensionless jigs or on winches. Cloth containing cotton warps may however be dyed on ordinary cotton jigs.

Rayon Dyeing.

Direct Dyestuffs.

For all practical purposes, where only moderate fastness is required, Direct dyestuffs such as Chlorazols are employed. From the Direct group of dyestuffs, Durazols, are commonly used for their exceptional fastness to light.

According to the depth of the desired shade,

5 – 20% Glauber's Salt or Common Salt, and
½ – 1% Soda Ash

are added to the dye bath. An addition of

½ –% Lissapol T or Calsolene Oil HS or Turkey Red Oil to the bath will help the penetration and levelling of the dyestuff.

The well-wtteed out material is generally entered at ordinary temperature, and the temperature is gradually raised to 160°–175°F., the dyeing being further carried out at this temperature for ¾ – 1 hour.

Aftertreatment ;

The fastness to light of certain dyestuffs is improved by after-treating the dyed rayon in a bath containing

1–3 % Copper Sulphate and
½–1½% Acetic Acid
for 15–20 minutes at 120°–140°F.

For improving the fastness to light and washing of certain dyestuffs, a combined copper-chrome aftertreatment is found useful. The dyeings are treated for 20–30 minutes at 140–160°F., with

1 – 2% Bichromate of Soda
1 – 2% Copper Sulphate
2 – 4% Acetic Acid

and rinsed.

A certain number of dyestuffs, when diazotised and developed with a suitable developer, produce dyeings fast to water, washing and cross-dyeing. Rayon dyed with such selected dyestuff is treated in a cold diazotising bath prepared with

2 – 3% Sodium Nitrite
3 – 5% Sulphuric Acid Conc.,

for 20 – 30 minutes, quickly rinsed and developed without delay in a separate bath prepared with the developer. The developers

most commonly used are Beta-Naphthol, Direct Developer Z, Developer H. or m-phenylene diamine. Beta-naphthol requires about half its own weight of Caustic Soda for complete solution, while Developer H or m-phenylene diamine can be dissolved by using half its weight of Soda Ash. Developer Z is soluble in water. For full shades about 1.5% of any of the above developers is required.

Sulphur Dyestuffs.

As a rule, Sulphur Dyestuffs are not used for dyeing rayon as the large amount of Soda Ash and Sodium Sulphide employed in the dyebath is liable to render the rayon very hard and brittle.

The dyestuff together with Sodium Sulphide is dissolved in boiling water.

The dyebath is set up at ordinary temperature with

2 - 3% Soda Ash

and the dissolved dyestuff. The wetted out rayon is entered and the temperature gradually raised to 140°F., the dyeing being finished at this temperature within 1 hour.

2 - 10% Glauber's Salt Calc., or Common Salt

is added to get better exhaustion of the dyebath.

½-1% Lissapol T, orIcipol Soap or Calsolene Oil HS will prevent the yarn from acquiring harsh feel. After dyeing, the yarn is washed, soaped hot and washed.

Basic Dyestuffs ;

Basic dyestuffs dyed on mordanted rayon yield shades faster to water, washing and rubbing than when dyed on unmordanted rayon. Pale shades may however be dyed without mordant. Mordants for Basic dyestuffs used are either tannic acid-antimony salt or Tanninol BM.

TANNINOL BM.

The rayon is mordanted for 1 hour at 100°-110°F., in a proportion of goods to liquor 1 : 20 to 1 : 30 with

4 - 8% Tanninol BM
2% Soda Ash
10% Common Salt or Glauber's Salt Calc.

After mordanting, rayon is washed and soured with Acetic Acid to remove the traces of Soda Ash.

Tannic Acid.

The bath is set up with

0.5 – 4% Tannic Acid &
0.5 – 1% Acetic Acid at 120°–140°F.

The yarn is entered and worked in the cooling bath for 2–3 hours turning frequently. The yarn is then lifted, the excess liquor allowed to drain or better still the yarn is hydroextracted and then aftertreated in cold for ½ hour in a bath prepared with 0.3–2% Antimony Salt or Tartar Emetic. The dyeing is done with 1–3% Acetic Acid. To obtain good levelness, the dyeing should be started cold and the dyestuff solution added to the dyebath in several portions. After the complete addition of dyestuff solution, the temperature is raised to 120°–140°F., and the dyeing is finished at this temperature.

Vat Dyestuffs ;

Vat dyestuffs–Caledons, Durindones,–possess exceptional all-round fastness. They are insoluble in water and to get them into solution require to be "vatted" with Caustic Soda and Hydrosulphite.

In view of the variations in the vatting and dyeing temperatures as well as the amount of alkali used in the case of all the vat dyestuffs, they are divided for all practical purposes into 4 different groups and are dyed by any one of the following four methods prescribed for the particular dyestuff.

In the following table are given the quantities of Caustic Soda, Salt and Hydrosulphite to be used for the dyestuffs dyed by the first three methods :

	Method 1.	Method 2.	Method 3.
Caustic Soda 98% Pdr. or flakes per 100 gallons dye liquor ..	3½–4 lbs.	1¾–2 lbs.	1¾–2 lbs.
Hydrosulphite Conc. Powder per 100 galls. .. dye–liquor	for pale shades ..		1½–2 lbs.
	for medium shades ..		2 –3 ,,
	for deep shades ..		3 –4 ,,
Glauber's Salt Conc. or Common Salt per 100 gallons dye–liquor	No addition of Salt	pale 0–2 lbs.	pale 2–4 lbs.
		medium 2–3,,	medium 4–6 ,,
		deep 4–5 ,,	deep 8–10 ,,
Vatting and Dyeing temperatures	120°–140°F.	110°–120°F.	80°–90°F.

Dissolving the Vat Dyestuff.

The paste brand is diluted with about 10 times its weight of water.

The powder fine brands are first carefully pasted with hot water and then diluted with about 50 times their weight of water. Ordinary powder brands are previously wetted, Icipol Brilliant Oil or with 3–5% solution of Lissapol T or Perminal W or Igepon T, and then mixed with water to a thin paste and diluted with about 40-50 times water. After heating up the diluted dyestuff to a prescribed temperature, one-third quantities of Caustic Soda and Hydrosulphite are added whilst slowly stirring. The mixture is allowed to stand for 20–30 minutes, when the colour will completely go into solution.

Dyeing ;

The dye bath is set up with the required volume of water and the remaining portions of Caustic Soda and Hydrosulphite. The dyestuff solution is then sieved in through a piece of cloth and the rayon entered. The bath is gradually heated to the temperature prescribed for the particular method and the dyeing is further carried at this temperature, for ¾ hour. The rayon yarn is then lifted up, allowed to drain, oxidized for 1–2 hours in the air whilst constantly turning the hanks, washed, soaped with 2% Soap ½% Soda Ash and ½% Lissapol T at 160°F, and finally washed.

Method No. 4—Special stock vat process for Durindone Oranges, Scarlets, Pinks and Magentas ;

The dyestuff is thoroughly pasted with an equal quantity of Icipol Soap and diluted with 50–100 times its weight of water. The temperature is raised to 170°–180°F and Caustic Soda and Hydrosulphite (generally double the quantity of dyestuff taken) are added whilst slowly stirring. Within about ½ hour the dyestuff is completely reduced and is then ready for use.

The dye bath is first primed with little quantities of Caustic Soda and Hydrosulphite and the dyestuff solution is sieved in through a piece of sack cloth. The rayon is entered and dyed at 120°–130°F., for about 1 hour, lifted up, drained and oxidized for 2 hours in the air and then finished as usual.

Special method of dyeing Vat Blacks.

The dye bath is set up at 140°F., with:

6 lbs. Caustic Soda &
5 – 6 lbs. Hydrosulphite

per 100 gallons dye liquor. The dyestuff finely pasted with 3% Lissapol solution or with Spirit and water after dilution with 2–3 gallons hot water is slowly stirred in. In about 15–20 mins. time the dyestuff is completely reduced. The rayon is then entered and dyed for 1 hour at 140°F., taken out, oxidized, washed and finished in the usual manner.

The dyeings produced with Caledon Black 2B brands give dark green shade instead of black. They are, therefore, after oxidation and washing treated in cold bleaching powder solution (containing 1 gm. available chlorine per litre) for ½ hour, washed soured and finished as usual. Alternatively, the green dyeings may be treated for ½ hour in a cold bath containing.

3% Sodium Nitrite &
5% Sulphuric Acid

calculated on the weight of the material, then washed and finished in the usual way.

Special notes on vat dyeing.

1. Whilst dyeing rayon with vat dyestuffs, about three-fourth quantity of Caustic Soda actually used for the cotton dyeing is quite sufficient, as excess amount of alkali interferes with the penetration and levelling of the dyestuff due to the swelling property of rayon in wet condition.

2. Vats Blues such as Caledon Blue R are best vatted in full liquor.

3. To get over the levelling difficulties whilst dyeing pale shades, 1–2 lbs. Glue per 100 gallons should be added to the dye bath.

4. Vat dyeing, even though they are thoroughly washed and soaped, show somewhat dulling effect. To restore the original lustre of rayon, the dyeings after oxidation and washing are soured with 1–2 lbs. Sulphuric Acid washed and then finished as usual.

5. It takes a long time for complete air oxidation of the vat dyeings on rayon. To accelerate the oxidation the dyeings may be treated for 15–20 minutes in a warm bath prepared with 2–3 lbs. Sodium Perborate per 100 gallons. This treatment should be specially followed in the case of Caledon Yellow GN and Caledon Red BN.

6. The dyeings produced with vat blues of GCD, RSN, R or 3G type turn green when chlorinated. The original shade is almost completely restored by the aftertreatment of the dyeings with 3–4 ozs. Hydrosulphite per 100 gallons of water in cold for 5–10 minutes.

Soledon Dyestuffs.

Soledon dyestuffs are the water soluble leuco-compounds of the vat dyestuffs. Naturally dyeings produced with this series of dyestuffs are of excellent allround fastness and are specially distinguished for their penetration and levelling. Their high cost do prevent their use on rayon for deep shades, but they are always preferred to vat dyestuffs, for producing fancy shades owing to their excellent levelling properties.

Method of dyeing ;

The dyestuffs are dissolved in soft water at a temperature not exceeding 175°F., or preferably with the addition of 1 lb. Lissapol T per 100 gallons. The solution is then added to the dye bath already prepared with the requisite quantities of water, Sodium Nitrite and Salt.

The dyeing is carried out within ¾ hour in a volume of liquor 1 : 30 at 105°–120°F. The following quantities of Salt and Sodium Nitrite are required per 100 gallons liquor :

DYESTUFF.	SODIUM NITRITE.	GLAUBER'S SALT CONC.
½ lb	3 lbs	7 lbs
1 lb	4 lbs	10 ,,
3 lbs	5 lbs	15 ,,
5 lbs	6 lbs	20 ,,
10 lbs	8 lbs	25 ,,

After dyeing, the rayon yarn or cloth is squeezed off or hydro-extracted and then without delay developed with 1–2 gallons Sulphuric Acid (168°Tw.) per 100 gallons at 105°F., for about 5 minutes. The dyeings are then washed, soaped hot and washed.

One bath method for dyeing fancy shades on rayon pieces on the winch;

This method should be followed only for dyeing up to 1% shade. The bath is set up with the dyestuff solution,

0.5% Calsolene Oil HS or Perminal W and
0.5% Lissapol T

The rayon pieces are worked in cold for about 10 minutes.

10% Glauber's Salt Calc. is added and after about 15 minutes more another addition of
5–10% Glauber's Salt Calc. is made
and the dyeing continued in cold for 10 minutes. The pieces are then lifted up and the addition of
0.5– 1% Sodium Nitrite &
10% Sulphuric Acid (on the weight of goods)
is made, the pieces entered and the temperature gradually raised to 105°–110°F., within 10–15 minutes. The bath is then run off and the dyeings are washed, soaped hot and finished as usual.

Brenthols on Rayon.

The dyeing of rayon with Brenthols is very similar to that of cotton. It is generally dyed in open vats or tubs in a proportion of goods to liquor of 1:20 to 1:30.

Owing to the better exhaustion of Brenthols on rayon the concentration of the impregnating bath should be kept half of that used for cotton.

Impregnation.

Brenthols are first pasted with the requisite quantity of Icipol Soap solution, the Caustic Soda added and the boiling water is poured over whilst stirring, when the Brenthols will completely go into solution. The rayon is impregnated in the Brenthol solution in the open vat or tub for about 15–20 minutes in cold, thoroughly hydroextracted and then developed.

Developing.

The developing bath is prepared with the requisite quantity of Brenthol Fast Salt or the diazo solution of Brenthol Base, previously diazotised with Sodium Nitrite and hydrochloric acid and carefully neutralised with Sodium Acetate.

The impregnated rayon is worked in cold in the developing bath for 20–30 minutes. The dyeings are then repeatedly washed in cold water, soaped hot and washed.

Aftertreatment:

The aftertreatment of the Brenthol dyeings deserve special attention. Brenthol combinations require a full boiling treatment with soap, soda ash or caustic soda in order to develop the real shade and to improve the fastness to rubbing. In the case of rayon the treatment should be carried out only at 160°–175°F. Even after repeated washings and soaping there remains the possibility of the dulling or matting effect on rayon due to the precipitation of Aluminium Salts, the traces of which are not completely removed from the fibre. The rayon dyeings therefore after one or two washings are treated with 2% Hydrochloric Acid on the weight of the material) at about 110–120°F for 10–20 minutes, washed and then soaped. The use of Sulphate of Alumina as binding agent should be avoided. It should be substituted by Acetic Acid. If not soured with Hydrochloric Acid, the rayon acquires a harsh feel. The rayon dyeings can be softened by an aftertreatment with 2–3% solution of Cirrasol LC or SA. Waxol P.

ACETATE SILK.

Acetate silk, being a cellulose-acetic acid-ester, cannot be dyed with ordinary direct or basic dyestuffs. The use of sulphur, vat and Brenthols for dyeing Acetate Silk is also prohibitive due to the saponification of ester taking place by the alkalies required to dye these colours. Special colours are therefore manufactured, which are easily dispersible in water and do not need alkali for their solution. Among these dyestuffs, Dispersols or Duranols.

Dyeing.

The requisite quantity of Dispersol Duranol dyestuffs is first pasted with little water or preferably with 2% solution of Lissapol and then diluted with sufficient quantity of cold water.

The dye bath is set up with water – the volume of goods to liquor being taken 1:30 to 1:50–at ordinary temperature, the dyestuff solution is added and the acetate silk previously wetted in hot water is entered. 3–5% Neutral Soap or Marseilles Soap is added to the dyebath. The temperature is then slowly raised to 140°–160°F within ½–¾ hour. For better exhaustion of medium and deep shades, an addition of 5–10 lbs Glauber's Salt Calc, is made to the dye bath at this stage and the dyeing further continued at 160°F., for ½–¾ hour. The silk is then washed thoroughly and given an aftertreatment with 1% Lissapol T at 140°F., for 20 minutes and dried without rinsing.

Sizing of Rayon.

Rayon yarn sold in the market is often already sized by the manufacturers. However, if this is not so or the yarn is insufficiently sized, it will be necessary to give it a sizing treatment in order that it should be smooth and have sufficient abrasion resistance and tensile strength to withstand the weaving operation. The most usual chemicals used for sizing rayon warps include Gelatione, Linseed Oil (applied from an organic solvent or from an emulsion in water) and starches. Softeners deliquesent and lubricants such as Tallow. Paraffin Wax, Sulphonated Oil, glycerine etc. may be included to give flexibility to the yarn.

Sizing formulae naturally vary greatly for different qualities of yarn and the sizing of rayon yarn has always been a somewhat difficult problem. Linseed Oil for instance, although giving a good sizing effect is often very difficult to remove from the fibre after weaving. Gelatine although comparatively readily removed from the fibre does not always give the best sizing. Recent work has indicated however, that among the modern range of watersoluble synthetic resins, there exist products which are more ideal for rayon sizing than the older materials.

Softening of Rayon Yarn.

The scouring, bleaching or dyeing operations render rayon yarn somewhat harsh and brittle–especially the yarn dyed with Sulphur, Vat or Brenthol dyestuffs. By a treatment with highly sulphonated oils or other softening and lubricating agents, the yarn can be softened as desired. Amongst the various preparations recommended for softening, the following are found by practical experience to be very efficient–Cirrasols SA and LC, Waxol P, Calsolene Oil HS, etc.

CHAPTER XLIV.

FINISHING.

It is almost always the case, when a bleacher, dyer, or finisher takes a position in India, that some other department is added to his own. The finisher, in addition to finishing bleached and dyed goods, will have the grey finishing department thrust on to him as well and he is supposed to know nearly everything, and no allowance is made for experimenting. A finisher in white or bleached goods will have to discard many of his recipes when handling grey goods, but such recipes may be used as basis for his grey finishes. He will find, in addition to grey goods reacting differently to bleached good with certain starches and softeners, that he may have to use the chemicals supplied to him by his firm, of which he does not know the origin. They may be good, different, or variable in quality, and he will be some little time in finding out where he stands. Here experience comes in useful.

The finisher accustomed to bleached goods will certainly have trouble at first in getting his width, for grey goods Shrink with every process, and are difficult to stretch. Firms who have not done much grey finishing do not like to allow for Shrinkage in the weaving, and getting the width back means extra operations, which lessen the production and increase the cost of the finishing process. It is as well, in the earlier stages to get on the right side of the weaving master, who can help or retard a finisher very much.

Woven cloth and Fabric is sent to the Finishing Room where it is placed on Inspection Boards or table. These comprise mechanically controlled devices which unroll the woven goods, pass it over suitable boards for inspection, and roll it again. At some of the mills the inspection is carried on by hand. Defects in the weaving are marked and the imperfect roll is later repaired by hand.

Oil spots and stains are detected and treated for subsequent removeal if they are not too extensive and if they are still relatively fresh. Serious staining may be sufficient reason for rejecting part of the weave and a consequent reason for rejecting part of the weave and a consequent loss in production. The nature of the spots detected on the inspection boards frequently points out the source

of the staining. For example, a stain running along the selvedge yarn indicates throw or spatter from the picking ball or tappet of the loom. Staining that is confined to weft yarn alone, or to warp yarn alone, indicates that the throw has occurred probably in the Spinning department Staining on both the weft and warp yarns indicates that the throw has occured on some of the various loom parts. Thus the nature of the staining guides operators in correcting the trouble at its source.

The cloth manufactured in a cotton mill is known as grey goods.

Finishing Process

Under the above headings are included those operations to which cotton goods are subjected after they are woven in the grey state, bleached, dyed, etc.

The function of finishing is to increase the value of the cloth. by modifying its important physical properties such as colour, softness or stiffness, lustre and thus give it that attractive appearance for which it was designed.

The treatment given varies greatly in "stiffness, feel, weight, lustre, etc.," as may be required by different merchants and markets, even for the same fabrics.

Finishing depends almost entirely upon machinery together with the feel produced by the introduction of various filling materials.

Filling or stiffening consists in introducing into cloth some gummy substance which, when dried, will render the cloth less limp in feel. It may vary from pure finish to a heavy filling, giving a 'full' or 'stiff' or 'boardy' feel and considerable increase in weight.

The stiffening solutions are applied to the cloth at open width by padding, and may be either applied to the back only or all through the fabric.

Duplicating a Sample

Finishing to sample is more difficult than producing new finishes. The first has a vague foundation to start with, and the processing conditions or the characteristics governing the production of the original sample in another plant cannot be duplicated 100 per cent. A new finish can be built on the knowledge and experience which the finisher has of the ingredients that he wishes to utilise.

Pure Finish.—Contains no filling material of any kind, is clothy to the handle, such as fine Shirtings, mulls, etc.

Filled Finish.—The cloth is filled by some combination of chemicals and increases in weight. The calendering, or mangling, may give it a soft or hard feel as required.

Back Filled.—The back of the fabric only has been treated to the filling materials and is quite visible, the face being free from the paste.

For back filling, the cloth does not pass through the liquor, but only over the surface of a roller half immersed in the trough, this roller carrying the liquor to the back of the cloth as it revolves.

The back may then be scraped with a 'doctor.' The cloth may be so guided round the cylinders of the drying machine that only one side of the fabric touches the lot hot cylinders until it is partially dried.

Many classes of grey goods require filling, some are calendered afterwards and others are taken from the end of the drying cylinders to the folding department. The best finishing range for the bulk of the work is a combination of a three-bowl Universal Mangle, and a set of drying cylinders. The Mangle consists of a top and bottom cotton bowl and a centre brass driving bowl. The distance between the mangle and the drying cylinders must be as little as possible to minimise shrinkage, cloth entering the starch box, connected with the mangle, must pass over a brass scrimp rail, and over another as it enters the nip. A Mycock or similar opener should be fitted between the mangle and the drying cylinders, as close as possible to the latter.

Another useful arrangement, where the weft must be kept straight, to bring out the width as much as possible, is to fit a short length of stenter between the mangle and drying cylinders. There is a standard range on the market embodying this arrangement. A heavy two-bowl starch mangle is a useful machine in a grey finishing department. It is suitable for any kind of heavy starch mixing. The lower bowl is of cotton and the upper driving bowl of brass.

Mercerized Finish.—The finish has been mercerized and can usually be detected by its face appearance.

Finishing Materials

The following materials used consist of :—

1. Adhesives.
2. Filling or weighting materials.
3. Softening agents.
4. Hydgroscopic substances.
5. Antiseptics.

The introduction of starch and other ingredients sets up a base on which finishes may be built.

Many of these built-up finishes are effected on the materials added to the fabric in the starching, and not altogether on the cotton, and could not be developed without their aid. Finishing includes all processes tending to change the condition or appearance of a fabric after it comes from the loom.

Wheaten Starch

Wheaten starch gives smooth and thick feel to the cloth finished with it. Starch takes a high gloss on calendering and beetling and on account of its powerful adhesive qualities acts as good carrier for china clay and other weighting substances. Wheaten starch will hold about twice its own weight of weighting materials without dusting off, and the cloth will stand handling after being dried and finished without the filling dusting off.

Farina

When boiled with water, produces a thicker paste than any of the other starches except maize. When applied to cloth it gives a thick mellow feel. This feel becomes softer on ageing, and for this reason, farina is more suitable for certain finishes where a 'full.' 'soft' feel is required. Farina has not the carrying powers of wheaten starch, but it will hold about one and a half times its own weight of china clay without dusting off when the cloth is handled.

The general commercial potato starches which will be found on analysis used alone do not produce uniform finishes, either in appearance or stiffness, and the starching is very much on the surface of the threads. This is due to the variation in the size of the starch grañules, a variation which often makes the starch prohibitive for use in some finishes. The granules of the starch must be uniform.

Rice Starch

Rice starch produces a full, firm and harsh feel, often described as a boardy feel in cloth filled with it. This starch is chiefly used for those classes of cloth which do not require a calender or beetle finish.

Maize Starch

Maize starch is somewhat similar in its properties to wheaten starch inasmuch as it retains the 'feel' produced in the cloth on ageing, but it gives a rather harsher feel. It has adhesive qualities about the same as wheaten starch. A mixture consisting of equal parts of maize starch and farina forms a very good starch filling "which gives a feel to cloth similar to that produced by wheaten starch."

Sago Starch

Sago starch produces a thinly firm feel in cloth finished with it, but it has a most objectionable property of cracking on the surface when the cloth is folded or creased. This broken appearance is very evident in goods which have been previously dyed. It must be thoroughly boiled before being used.

The uniformity of the granule of Sago starch permits of its use as one of the best starches for pure finisnhing. It penetrates well with the appearance of a thin, transparent film having been applied to the goods, it produces a soft feel after drying and cooling, and is adaptable to the starching of light fabrics, expecially those in stripes.

Tapioca starch boils up with a thick paste, and penetrates well, but not as deeply as wheat starch. It dries up with the indication of a filmy surface, and exhibits a soft feel in the piece. Its Characteristics are very similar to those of sago. It is not considered as good a binder as wheat, corn or potato starch. On long boiling it losses its stiffening qualities. It promotes the growth of mildew very rapidly when used alone, but may be used satisfactorily with corn starch.

Dextrine

Soluble starch and white dextrine are most valuable agents in the hands of the finisher. Being soluble, they form a thin liquid, when boiled with water, which penetrates the fibres of the cloth,

instead of remaining on the surface only as is the case with starch. These substances produce a thickly firm feel in cloth finished with them. They also have the property of causing starch to boil thinner than when this substance is boiled with water alone. This is an advantage when it is required to give a thickly 'leathery' feel to low class cloth in which for certain reasons, china clay or other materials are not permissible ingredients.

Softening Materials

The softening materials used are oils or fatty matters such as tallow, cocoanut oil, castor oil, soluble oil, olive oil, soaps, oleine oils and sometimes glucose or glycerine, etc. One or other of these substances is necessary in mixing for nearly all classes of finishes in order to modify the more or less harsh feel given to the cloth by the starches and china clay; good results in finishing can only be obtained by careful and proper use of the machinery employed, combined with the skill of the operative in the use of the correct mixing of filling.

An excess of softener will dull the appearance of a finish, destroy the characteristics of the starches and present a limpy or a loose fabric.

Weighting Materials

For adding weight to the goods, the chief materials used are china clay and mineral white (sulphate of calcium). A good quality of china clay should always be selected or the finishing of white goods. It should have a somewhat soapy feel and be free from particles of grit, and possess a good white colour free from yellowish veins. French chalk is used for the same purpose, but is more expensive. Barytes is also used, being heavy and adding much weight. Soluble weighting substances are also employed, such as Epsom salts and Glaubers salts. Their presence is not evident to the eye like china clay, but they will not fill up a poor cloth like the latter. Quite a large quantity of epsom salts may be introduced into cotton goods without any alteration in feel or appearance.

Hygroscopic Materials

Hygroscopic substances are used to give softness, much the same as the softening agents given above, which they sometimes replace. They act by attracting moisture from the air. The salts used are magnesium chloride, calcium chloride, zinc chloride; the latter also acts as a powerful antiseptic substance preventing the formation of mildew. Glycerine and glucose are also hygroscopic.

Antiseptics

Besides the chloride of zinc, salicylic acid, boric acid, etc. are also used.

The bulk of grey goods finished require an Epsom salts mixing, containing a small percentage of magnesium chloride as deliquescent and zinc chloride as antiseptic. This is run at any strength from 20 degrees to 64 degrees twaddle. Higher than 64 degrees in strength is not to be recommended, as difficulties arise as caking on the drying cylinders and the Mycock opener. Epsom Salts mixing is suitable for coloured goods, but a white dextrine mixture gives a rather better handle. Thick starch mixings containing wax, for goods which are to be frictioned, are used in the heavy two—bowl mangle.

Blueing of White Fabrics

This is usually done together with the finishing. The solutions of the respective dyestuffs are added to the finishing liquor, e.g. for a durable, fast-to-light blueing for 100 gallons of finishing liquor as follows :—

For a Violet tint.

5 oz. Indenthren Blue RZ paste and
¾ of. Eglantine BBP paste,

For a greenish tint.

3 oz. Indanthren Blue GGSZ paste and
3 oz. Indanthren Blue RZ paste.

In order to obtain an even blueing an addition of less than ¼ oz. Igepon T, Soromine AF or SG to the blueing bath is advisable. This, at the same time, imparts an agreeably soft and characteristic handle to the goods.

Finishing of Rayon Piece Goods

The finishing processes for rayon piece goods as with other fibres may be chemical, mechanical or a combination of both.

The following are the main types of finishing effects demanded on rayon piece goods :—

(1) Softening
(2) Weighting, filling and sometimes stiffening.
(3) Scrooping.
(4) Dulling.
(5) Non-slipping.
(6) Waterproofing.
(7) Anti Creasing.
(8) Non Shrinking.

Any one or a combination of several of these effects may be required according to the type of fabric being treated and the market requirements. For instance one cloth may need a soft, full, plump feel. Another may have to be soft and waterproofed and on yet another an anticrease finish with a soft feel may be required. The actual finishing formulae used will naturally vary greatly to suit individual requirements.

Rayon finishing is a highly specialised business and needs much experience and skill. The chemicals normally used in finishing cotton are frequently quite unsuitable for rayon finishing. As a result a number of highly specialised finishing agents have been marketed (many covered by patents).) which have been specially devised for application to these fibres. In the notes below some of the more well known of these are mentioned.

Softening.

The cheaper types of chemicals for producing a soft, smooth finish include wax preparations and sulphonated oils: but special preparations which find considerable applications for this purpose owing to their greater stability and more powerful softening action are Lissapol T, Cirrasol SA or Cirrasol LC, Velan PF, Waxol P and Waxol T, etc. The process of application of any of these products consists simply in padding or running the goods on a winch in a solution or dispersion of one or more of the above products (according to the finish required) removing the excess liquor and drying. Solution concentrations may vary from 2–4 oz. per 100 gallons with Velan PF up to 1–3 lbs. per 100 gallons with other agents.

Weighting filling & Stiffening.

The giving to rayon of a heavy, full handle which often must also be soft is frequently demanded. Spun rayon which is well known to be often flabby in hadle generally requires a treatment of this type. Weighting and filling may be carried out by the use of cheap products such as Gelatine, Starch and Pigments with the addition of glycerine as a deliquescent and one or more of the lubricants or softeners noted above. If after treatment with agents of this type a finish come out too stiff it is general to give the cloth one or more runs through a button breaker which breaks the film of finishing agents thus rendering the finish less rigid and more soft. By the introduction of newer and better finishing chemicals for rayon finishing the use of the button breaker is on the whole decreasing.

The more recent introduction of synthetic resins has put into the hands of rayon finishers a new weapon with which to attack finishing problems of this nature. Many of these synthetic resins have been found to be particularly suitable for rayon finishings giving that full handle without stuffness which is so often needed on rayon fabrics. Many of these synthetic resins give finishes which are fast to washing and dry cleaning. Synthetic resin products of this nature are discussed in more detail in the section dealing with modern finishing agents. Typical examples of such products are Bedafin D. Bedafin A, Bedafin 2001, etc.

Non Slip Finishing

Certain types of rayon fabrics more particularly rayon sateen and taffetas suffer from the defect that the warp threads in the material slip very easily over the weft threads. A slight pull or plucking causes the threads to slip together at the point of plucking thus distorting the fabric and often producing an apparent hole in the material.

This defect can be minimised or overcome by treatment with suitable adhesives. Such treatments, however, often spoil the handle of the material making it stiff, harsh and unsuitable. Recent work has produced chemicals such as Pinosin B which overcome this difficulty giving a non slip finish combined with a satisfactory feel. Certain synthetic products are also suitable for this purpose.

Waterproofing & Spot proofing

Waterproofing of rayon materials particularly dress materials and ribbons, is often carried out partly to give these materials resistance to wetting and partly to give them increased resistance to

staining dirtying. Many rayon fabrics when spotted with water show unsightly spots which do not disappear on drying. Waterproofing the material and thus giving it resistance to wetting helps very considerably to overcome this defect. Waterproofed fabrics also are far more resistant to staining by coloured liquids than untreated materials.

The older methods of waterproofing, based on application of Aluminium Salts or waxes, are unsuited to delicate rayon fabrics owing to the very harsh feel which such treatments give to the cloth.

Modern waterproofing chemicals such as Waxol W are a great improvement on this respect, giving good waterproofing and spot proofing without rendering the fabric too harsh and stiff.

The method of applying Waxol W is very simple. The material is impregnated with Waxol solution at 120°F. squeezed and dried at a temperature above 140°F. The higher the drying temperature is, the more efficient the waterproofing. The concentration of the impregnating bath may vary from 1–3 lbs. Waxol W according to the degree of proofing desired.

Velan PF is a patented waterproofing preparation introduced into the market a few years ago, which not only gives very efficient waterproof and spot-proof finishes, but at the same time softns the cloth. The finish is unique in that it is fast to washing and dry cleaning, no other waterproof finish possessing this property. The product is said to be particularly suitable for application to rayon owing to the very attractive, smooth, soft water-repellent finihs which it produces.

Rayon fabrics are treated on a winch or a padding mangle in a dispersion of 2–4 lbs. Velan PF in 10 gallons of water. The Velan bath must contain 5 ozs. of Sodium Acetate per 1 lb. of Velan used.

After treating the fabrics in the Velan bath, they are dried, baked at 266°F for 3–4 minutes or 302°F. for $1\frac{1}{2}$–$2\frac{1}{2}$ minutes and washed at 140°F with 1–2 lbs. soap and 1 lb. soda ash per 100 gallons of water. The washing process, however, must be modified according to the fastness of the dyeings being treated.

Acetate silk being more difficult to penetrate, it is advisable to add 10–15% by volume of Methylated Spirit to the solution of Velan PF. The drying, baking and washing processes for acetate silk follow normal lines. While baking, the temperature should not exceed 285°F (140°C).

Fuller details as to the properties and methods of application of Velan PF are given in the section of "Modern Finisnhing Agents."

Anticreasing

Rayon fabrics have in general poor resistance to creasing and are inferior to cotton in this respect. Many methods have been tried for improving their crease resistance, but to-date the most suitable method is that discovered and patented by Messrs. Tootall Broadhurst & Lee of England. This involves treatment of rayon fabrics with a water-solutioble Urea Formaldehyde condensate followed by drying and heat treating the fabric to fix the resin in the fibre. This process not only gives a good crease resistant finish which is fast to washing, but also serves to fill and weight the fabric.

Non Shrink Finishes

Mechanical processes for the controlled shrinkage of cloth in order to produce a material which is fully shrunk and therefore, will not shrink any more on washing, have been introduced now for some years. The Sanforizing process and the Rigmel processes are probably the most well known of these methods. Rayon fabrics can be rendered non-shrinking by these processes.

A very interesting recent innovation in finishing which comes from England is the production by chemical methods of a non-shrinking rayon crepe fabric. Crepe fabrics normally shrink very badly on washing.

Mechanical Side of Finishing

Finishing solution may be applied to rayon fabrics by spraying, by the various forms of padding or by working the goods on a winch in the finishing solution.

Excess liquor may be removed by squeezing in open width or if the goods are too delicate for this, by passing them over a vacuum slot which removes excess liquor by suction. Drying is generally carried out to width on a pin stenter.

As already noted if the goods come out too stiff in handle they may frequently be rendered softer by passing through a button breaker. The handle and appearance of flat goods may be modified by calendering on suitable rayon calenders.

CHAPTER XLV.

FINISHING MIXINGS.

Particulars of Vat.

TB. =31", BB =25," Depth =33½".
2.24 gallons to 1 inch.

The above vat is used for preparing china clay.

Size of Vat.

9" Sq. 37¾" Deep.
Gals. per inch =5.5.

The above vat is used for preparing the mixing.

---

(1) *Grey cloth—Light Finish.*

Farina	=	20 lbs.
Corn starch	=	30 ,,
Dextrin	=	30 ,,
Olive oil	=	12 ,,
Water	=	80 Gallons.

Boil 20 Minutes.

---

(2) 1 *lb. Finish for Grey Shirting.*

Wheat Flour	=	15 lbs.
Soluble Starch	=	15 ,,
Sago Starch	=	40 ,,
Penetrose	=	15 ,,
Chloride of Zinc	..	4 ,, (Solid)
French chalk	=	20 ,,
Mineral white	=	20 ,,
China clay	=	128 ,,
Blue	=	at discretion.
Water	=	54 Gallons.

Boil until begins to thicken.

(3) 1 *lb. Finish for Mexican, Shirting, and T Cloth.*

Farina	=	20 lbs.
Wheat Flour	=	9 ,,
Sago Starch	=	20 ,,
Maize starch	=	3 ,,
Mineral white	=	18 ,,
Chloride of Zinc	=	4 ,, (Solid)
French chalk	=	20 ,,
China clay	=	128 ,,
Blue	=	at discretion.
Water	=	54 Gallons.

Take 54 gallons of water, mix all the ingredients with the exception of clay, one by one, and stir well. Add china clay and boil until it begins to thicken and then stop the steam.

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(4) 3 *lbs. Finish for T. Cloth.*

Wheat Flour	=	28 lbs.
Soluble Starch	=	10 lbs.
Penetrose	=	20 lbs.
China clay	=	56 lbs.
Epson Salt	=	112 lbs.
Ch. of Zinc (Solid)	=	10 lbs.
Ch. of Mag. (Solid)	=	20 lbs.
Twaddle	=	75°

Boil until begins to thicken.

---

(5) *Light Finish—For Shirtings.*

Also for Black Susi cloth and Black & Red dyed cloth.

Sago Flour	=	6 lbs.
Maize Starch	=	5 ,,
Cocoanut oil	=	8 ozs.
China clay	=	1 lb.
Paraffin wax	=	6 ozs.
Ch. of Zinc	=	1 oz.
Water	=	21 Gallons.

(6) *Light Finish—For Black Dyed cloth.*

Farina	=	8 lbs.
Soluble starch	=	6 lbs.
Glucose	=	½ lb.
P. Wax	=	½ lb.
Tallow (mutton)	=	1 lb.
T. Red oil	=	3 lbs.
Black Dye	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

Pass cloth through the finish once.

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(7) *Light Finish—For Shirting.*

Corn Starch	=	125 lbs.
Gum	=	25 ,,
Tallow (mutton)	=	12 ,,
Water	=	98 Gallons.

Boil until thickens.

---

(8) *Light Finish—For Sheeting.*

Farina	=	110 lbs.
Gum	=	20 lbs.
Tallow (mutton)	=	12 lbs.
Water	=	98 Gallons.

Bring to a boil and then stop the steam otherwise by a longer boiling the consistency of the mixture will be lowered.

---

(9) *Light Finish—For Grey cloth.*

Farina	=	40 lbs.
Corn Starch	=	40 lbs.
Cocoanut oil	=	6 lbs.
Olive oil	=	6 lbs.
Water	=	80 Gallons.

Boil 20 Minutes.

---

(10) *Light Finish—Plain cloth.*

Wheaten Starch	=	40 lbs.
Farina	=	20 lbs.
Cocoanut oil	=	1½ lbs.
Ch. of Zinc (Solid)	=	2 lbs.
Blue	=	at discretion.
Water	=	65 Gallons.

Boil 20 Minutes.

(11) *Soft Finish—For Shirting.*

Farina	=	10 lbs.
Wheaten Starch	=	20 lbs.
Dextrin White	=	5 lbs.
Turkey Red oil	=	8 lbs.
Ch. of Zinc	=	5 ozs.
Blue	=	at discretion.
Water	=	60 Gallons.

Boil for 20 Minutes.

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(12) *Firm Finish—For Shirting.*

Corn Starch	=	10 lbs.
Dextrin	=	10 lbs.
Wheaten Starch	=	60 lbs.
Farina	=	30 lbs.
China Clay	=	200 lbs.
Turkey Red oil (50%)	=	12 lbs.
Ch. of Zinc	=	4 lbs.
Blue	=	at discretion.
Water	=	54 Gallons.

Boil for 20 minutes.

---

13) *Light Finish—For Black Dyed cloth (Fast colour).*

Dextrin	=	40 lbs.
Penetrose	=	20 lbs.
Farina	=	20 lbs.
Liq. ammonia	=	10 ozs.
Water	=	54 Gallons.

Boil 20 Minutes.

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(14) 1 *lb. Finish for Coloured cloth.*

Epson Salt	=	224 lbs.
China clay	=	56 lbs.
Ch. of Mag. (56°Tw)	=	14 lbs.
Ch. of Zinc (92° Tw)	=	5 Gallons.
Twaddle	=	45°

Note ;—

For adding ¼ lb.	=	80° Tw
„ „ ¾ lb.	=	80° Tw
„ „ ¾ lb.	=	85° „
„ „ 1¼ lb.	=	55° „
„ „ lb. 1½	=	60° „

(15) *Light Finish—For Kadar cloth.*

Soluble Starch	=	40 lbs.
Farina	=	5 lbs.
Rice Starch	=	4 lbs.
Epsom Salt	=	30 lbs.
Glucose	=	8 lbs.
Paraffin wax	=	5 lbs.
Tallow	=	5 lbs.
French Chalk	=	20 lbs.
China Clay	=	20 lbs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

---

(16) *Light Finish—For Kadar cloth.*

Maize Starch	=	60 lbs.
Epsom Salt	=	40 lbs.
China clay	=	50 lbs.
French chalk	=	10 lbs.
To Red oil	=	5 lbs.
Paraffin wax	=	2 lbs.
Stearine Paste	=	2 lbs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

---

(17) *Light Finish—For Shirting cloth.*

Maize Staech	=	20 lbs.
Epsom Salt	=	20 lbs.
Farina	=	20 lbs.
Soluble Starch	=	10 lbs.
Gum	=	2 lbs.
T. Red oil	=	4 lbs.
French chalk	=	10 lbs.
China clay	=	30 lbs.
Stearine paste	=	4 lbs.
Tallow	=	2 lbs.
Blue		at discretion.
Water	=	70 Gallons.

Boil until thickens.

(18) *Light Finish—For Long cloth and Shirting.*

Rice Starch	=	75 lbs.
China clay	=	40 lbs.
French chalk	=	40 lbs.
T. Pad oil	=	8 lbs.
Mutton Tallow	=	4 lbs.
Ultramarine Blue	=	$1\frac{1}{8}$ lbs.
Water	=	70 to 75 Gallons.

Boil 20 Minutes.

N.B.—In accordance to consistency or percentage required the water may be increased or reduced.

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(19) *Light size—For Japanese L. cloth or Fine Long cloth.*

Soluble starch	=	20 lbs.
Sago Flour	=	10 lbs.
Farina	=	35 lbs.
China Clay	=	40 lbs.
Stearine Paste	=	5 lbs.
T. Red Oil	=	7 lbs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

---

(20) *Light size—For Mulmul.*

Maize starch	=	20 lbs.
Borax	=	1 lb.
Epsom Salt	=	20 lbs.
Soluble Starch	=	5 lbs.
Gum	=	2 lb.
Cocoanut oil	=	1 lb.
Mutton Tallow	=	4 lbs.
T. R. oil	=	4 lbs.
French Chalk	=	20 lbs.
China Clay	=	20 lbs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

(21) *Nainsook Finish.*

Penetrose	=	80 lbs.
Olive oil 50%	=	8 lbs.
T. Red oil 60%	=	1 lb.
Glycerine	=	1 lb.
Carbolic acid No. 5.	=	¼ pint.
Blue	=	at discretion.
Water	=	90 Gallons.

Boil 20 minutes.

---

(22) *Muslin Dress Finish.*

Penetrose	=	20 lbs.
Farina	=	30 lbs.
Carbolic acid No. 5	=	½ Pint.
Blue	=	at discretion.
Water	=	90 Gallons.

Boil 20 minutes.

---

(23) *Finish—For Pagri Cloth.*

Farina	=	50 lbs.
China Clay.	=	60 lbs.
French Chalk	=	10 lbs.
Mineral white	=	10 lbs.
Glycerine	=	1 lb.
Salycilic acid	=	4 ozs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil 20 minutes.

---

(24) *Medium Finish—For Shirtings and Susi cloth.*

Sago Flour	=	60 lbs.
Maize Starch	=	40 lbs.
Cocoanut oil	=	2 lbs.
Glycerine	=	1½ lb.
China clay	=	2 lbs.
French chalk	=	1 lb.
Mineral white	=	1 lb.
Ch. of Zinc (Solid)	=	1 lb.
Blue	=	at discretion.
Water	=	100 Gallons.

Boil until thickens.

N. B.—The above mixing can be used as Light Finish by increasing the quantity of water to 220 Gallons; and if extra light finish is required then increase the quantity of water to about 400 Gallons.

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(25) *Heavy Finishing—For Grey Cloth.*

Farina	=	30 lbs.
Soluble Starch	=	20 lbs.
Penetrose	=	40 lbs.
China Clay	=	132 lbs.
Paraffin wax	=	1 lb.
Ch. of Zinc (Solid)	=	3 lbs.
T. R. Oil	=	1 lb.
Mutton Tallow	=	13 lbs.
Glycerine	=	1 lb.
Blue	=	at discretion.
Water	=	90 Gallons.

Bring to a Boil.

---

(26) *Heavy Finish—For Shirting.*

Wheaten Starch	=	60 lbs.
Farina	=	20 lbs.
Corn Starch	=	30 lbs.
T. R. oil (50%)	=	11 lbs.
Mutton Tallow	=	6 lbs.
Paraffin wax	=	2 lbs.
Cocoanut oil	=	1 lb.
Ch. of Zinc (Solid)	=	2 lb.
Blue	=	at discretion.
Water	=	90 Gallons.

Boil for 20 minutes.

---

(27) *Heavy Finish—For Black Dyed cloth.*

Sago Flour	=	140 lbs.
Maize Starch	=	28 lbs.
China clay	=	3 lbs.
French chalk	=	1 lb.
Cocoanut oil	=	4 lbs.
Glycerine	=	4 lbs.
Paraffin wax	=	2 lbs.
Ch. of Zinc (Solid)	=	2 lbs.
Black Dye	=	at discretion.
Water	=	98 Gallons.

Bring to a boil.

(28) *Heavy Finish—For Dyed Shirting.*

Sago Flour	=	50 lbs.
Farina	=	60 lbs.
Dextrin	=	30 lbs.
Epsom Salt	=	40 lbs.
Paraffin wax	=	5 lbs.
Glucose	=	5 lbs.
Tallow	=	2 lbs.
Soap	=	1 lb.
Cocoanut oil	=	6 ozs.
Glycerine	=	3 ozs.
T. R. oil (50%)	=	6 ozs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

(29) *Heavy Finish—For Black Susi cloth.*

Sago Flour	=	100 lbs.
Maize starch	=	40 lbs.
China clay	=	2 lbs.
Cocoanut oil	=	1 lb.
Ch. of Zinc	=	2 ozs.
Water	=	70 Gallons.

Boil until thickens.

(20) *Medium Finish—For Black Dyed cloth.*

Wheat Flour	=	20 lbs.
Farina	=	10 lbs.
Maize Starch	=	10 lbs.
Rice Starch	=	10 lbs.
Epsom Salt	=	30 lbs.
China clay	=	20 lbs.
French chalk.	=	10 lbs.
Paraffin wax	=	5 lbs.
Mutton Tallow.	=	3 lbs.
Stearine Paste	=	1 lb.
T. Red oil	=	1 lb.
Black Dye	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

(31) *Heavy Finish—For Black Dyed cloth.*

Maize Starch	=	60 lbs.
Farina	=	30 lbs.
Dextrin	=	40 lbs.
Soluble Starch	=	10 lbs.
Epsom Salt	=	35 lbs.
P. Wax	=	4 lbs.
Tallow	=	6 lbs.
Gum	=	2 lbs.
Black Dye	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

N. B.—Pass once or twice through the mixing as the weight or feel may demand.

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(32) *Heavy Finish—For Kadar cloth.*

Maize Starch	=	30 lbs.
Farina	=	25 lbs.
Wheat Flour	=	35 lbs.
Rice Starch	=	5 lbs.
Epsom Salt	=	30 lbs.
Paraffin Wax	..	3 lbs.
Mutton Tallow	=	4 lbs.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.
Pass twice.

---

(33) *Light Finish—For Black Dyed cloth.*

Farina	=	10 lbs.
Soluble Starch	=	6 lbs.
Paraffin wax	=	1 lb.
Mutton Tallow	=	1 lb.
T. R. oil	=	2lbs.
Black Dye	=	at discretion.
Water	=	70 Gallons.

The cloth is finished while still wet Straight from the Jigger.

(34) *Light Finish—For Fancy coloured chaddar.*

Maize starch	=	10 lbs.
Epsom salt	=	20 lbs.
China clay	=	20 lbs.
French Chalk	=	20 lbs.
Soluble Starch	=	6 lbs.
Mutton Tallow	=	5 lbs.
Gum	=	2 lbs.
Stearine paste	=	5 lbs.
Rice Starch	=	20 lbs.
Paraffin wax	=	5 lbs.
Borax	=	1 lb.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

---

(35) *Medium Finish—For Black Dyed Drill.*

Maize Starch	=	30 lbs.
Farina	=	15 lbs.
Wheat Flour	=	20 lbs.
Soluble Starch	=	5 lbs.
Gum	=	2 lbs.
Paraffin Wax	=	5 lbs.
Mutton Tallow	=	5 lbs.
Black Dye	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.
Pass once.

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(36) *Medium Finish—For Black Dyed Drill cloth.*

Maize Starch	=	25 lbs.
Farina	=	20 lbs.
Epsom Salt	=	25 lbs.
China clay	=	10 lbs.
Paraffin wax	=	3 lbs.
Mutton Tallow	=	3 lbs.
T. Red oil	=	5 lbs.
Black Dye	=	at discretion.
Water	=	70 Gallons.

Boil until thickens.

(37) *Medium Finish—For Plain Dyed cloth.*

White Dextrin	=	70 lbs.
Farina	=	30 lbs.
Penetrose	=	20 lbs.
T. Red oil (50%)	=	20 lbs.
Cocoanut oil	=	2 lbs.
Glycerine	=	2 lbs.
Olive oil	=	2 lbs.
Mutton Tallow	=	1 lb.
Soap (best quality)	=	1 lb.
Carbolic acid (No. 5.)		½ Pint.
Black Dye.	=	at discretion.
Water	=	80 Gallons.

Boil until thickens.

---

(38) *Lustrous Finish—For Black Dyed cloth.*

Corn Starch	=	30 lbs.
Yellow Dextrin	=	200 lbs.
Pearl Sago	=	50 lbs.
Japan wax	=	18 lbs.
T. Red oil	=	16 lbs.
Pine oil	=	2 lbs.
Soap (best quality)	=	8 ozs.
Cocoanut oil	=	8 ozs.
Black Dye	=	at discretion.
Carbolic oil (No. 5)	=	1 Pint.
Water	=	80 Gallons.

Boil until thickens.

N. B.—1 Pint of Liquid ammonia mixed in two gallons of water and 400 lbs. of Farina brightens the fast coloured stripes in finished cloth.

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(39) *Medium Finish—For Dyed cloth.*

Farina	=	42 lbs.
Wheat Flour	=	5 lbs.
Rice Starch	=	5 lbs.
Penetrose	=	18 lbs.
Mutton Tallow	=	6 lbs.
T. Red oil	=	3 lbs.
Paraffin wax	=	1 lb.
Water	=	70 Gallons.

Boil until thickens.

(40) *Light Finish—For Bapta cloth.*

Wheat Flour	=	10 lbs.
Farina	=	30 lbs.
Rice Starch	=	4 lbs.
Dextrin	=	10 lbs.
Maize Starch	=	10 lbs.
Mutton Tallow	=	6 lbs.
T. Red oil	=	1 lb.
Paraffin wax	=	2 lbs.
Ch. of Zinc.	=	4 ozs.
Water	=	70 Gallons.

Boil until thickens.

---

(41) *Medium Finish—For Red dyed Shirtings, whole coloured Saris and Gadipat.*

Maize Starch	=	60 lbs.
Cocoanut oil	=	8 ozs.
Turkey Red oil	=	8 ozs.
Epsom Salt	=	40 lbs.
Ch. of Zinc	=	2 ozs.
Water	=	70 Gallons.

Boil until thickens.

---

(42) *Medium Finish—For Sholapur coloured Sarees.*

Epsom Salt	=	112 lbs.
Glaubers Salt	=	28 lbs.
Farina	=	10 lbs.
Soluble Starch	=	10 lbs.
Penetrose	=	10 lbs.
Ch. of Zinc (102°Tw)	=	8 lbs.

Boil Epsom Salt for 10 minutes in one inch of water until dissolved, add Glaubers salt. Boil for 5 minutes. Add the starches. Boil for 10 minutes. No Steam is necessary while in process.

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(43) *Light Finish—For Sholapur coloured Saree.*

Farina	=	25 lbs.
Soluble Starch	=	35 lbs.
Penetrose	=	40 lbs.
Glucose	=	15 lbs.
Mutton Tallow	=	10 lbs.
Ch. of Zinc (102°Tw)	=	8 lbs.
Water	=	150 to 160 Gallons.

Boil 20 minutes.

(44) 1 *lb. Finish—For Coloured check.*

Wheat Flour	=	10 lbs.
Penetrose	=	10 lbs.
Soluble Starch	=	10 lbs.
Mineral white	=	30 lbs.
China clay	=	120 lbs.
Cocoanut oil	=	2 lbs.
Ch. of Zinc (102°Tw)	=	8 ozs.
Water	=	53 Gallons.

Bring up to a boil.

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(45) 1 *lb. Finish—For Plain Drill* 25″ ×40″ $\times \frac{10\frac{1}{4}}{11\frac{1}{4}}$

224 Epsom Salt

Stiffen at 40°Tw.

The narrower the cloth the lesser the twaddle and Vice Versa.

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(46) *Salt Finish—For Fancy Stripe Drill.*

Take one inch of water and add to it 2 bags of Epsom Salt. Boil ½ to 1 hr. until salt is well mixed.

Twaddle as follows :—

24″ ×40 yds ×9¼ lbs. = 34° Tw.
25″ ×40 yds. ×10¼ lbs. = 40° Tw.
36″ ×24 yds.—check cloth =50° Tw.
36″ ×6 yds—Sholapur Col. Saree =48 to 50° Tw.

Narrower the cloth lesser the twaddle and vice Versa.

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(47) *Medium Finish—For Plain White Drill.*

Farina	=	60 lbs.
Penetrose	=	30 lbs.
Sago Flour	=	30 lbs.
White Dextrin	=	110 lbs.
Turkey Red oil 50%	=	20 lbs.
Ch. of Zinc (102°Tw)	=	1 lb.
Blue	=	at discretion.
Water	=	90 Gallons.

Boil for 20 minutes.

(48) *Finish—for Satin Drill.*

White Dextrin	=	100 lbs.
Penetrose	=	20 lbs.
Farina	=	60 lbs.
Turkey Red oil	=	8 lbs.
Olive oil	=	2 lbs.
Glycerine	=	2 lbs.
Pine oil	=	1 lb.
Carbolic acid (No. 5)	=	¼ Pint.
Water	=	85 Gallons.

Boil 20 minutes.

(49) *Medium Finish—For Plain Drill.*

Epsom Salt (40° Tw)	=	4 cwt.
French chalk	=	50 lbs.
Glucose	=	5 lbs.
Water	=	70 Gallons.

Boil 20 Minutes.

(50) *Light Finish—For Twill Shirting.*

Soluble Starch	=	30 lbs.
Penetrose	=	10 lbs.
Farina	=	5 lbs.
Sago Flour	=	5 lbs.
Cocoanut oil	=	6 lbs.
Glycerine	=	1 lb.
T. Red oil.	=	1 lb.
Ch. of Zinc	=	8 ozs.
Blue	=	at discretion.
Water	=	85 Gallons.

Boil 20 minutes.

(51) *Light Finish—For Khaki Twill.*

Maize Starch	=	20 lbs.
Sago Flour	=	20 lbs.
Farina	=	12 lbs.
Cocoanut oil	=	1½ lb.
Ch. of Zinc	=	4 ozs.
Water	=	96 Gallons.

Boil for about 30 minutes.

(52) *Light Finish—For Bleaching Dhoty.*

Farina	=	28 lbs.
China clay	=	30 lbs.
Epsom Salt	=	4 lbs.
Glycerine	=	8 ozs.
Cocoanut oil	=	4 ozs.
Soap (Best)	=	½ lb.
T. Red oil	=	1 lb.
Ch. of Zinc	=	2 ozs.
Water	=	140 Gallons.

Boil 30 minutes.

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(53) *Light Finish—For Dhoty.*

Farina	=	20 lbs.
Soluble Starch	=	10 lbs.
Penetrose	=	10 lbs.
Sago Flour	=	5 lbs.
French chalk	=	5 lbs.
Cocoanut oil	=	10 lbs.
Glycerine	=	2 lbs.
Japan wax	=	½ lb.
Borax	=	1 lb.
Ch. of Zinc	=	2 ozs.
Blue	=	at discretion.
Water	=	90 Gallons.

Boil about 30 minutes.

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(54) *Light Finish—For Twill cloth.*

Farina	=	30 lbs.
Soluble Starch	=	20 lbs.
Dextrine	=	150 lbs.
Penetrose	=	30 lbs.
Olive oil (50%)	=	7½ Gallons.
Carbolic (acid No. 5)	=	½ Pint.
Blue	=	at discretion.
Water	=	100 Gallons.

Boil for about 25 minutes.

(55) *Finishing Mixing—For Twill Shirting.*

Farina	=	35 lbs.
Penetrose	=	15 lbs.
French chalk	=	5 lbs.
Cocoanut oil	=	18 lbs.
Ch. of Zinc	=	4 ozs.
Blue	=	at discretion.
Water	=	85 Gallons.

Boil about 20 minutes.

(56) *Finishing Mixing—For Dhoties and Sarees.*

Maize Starch	=	10 lbs.
Farina	=	5 lbs.
Soluble Starch	=	10 lbs.
Glucose	=	1 lb.
Tallow	=	1 lb.
T. Red oil	=	1 lb.
Cocoanut oil		1 lb.
Pine oil	=	½ lb.
French chalk	=	5 lb.
Mineral white	=	1 lb.
China clay	=	10 lbs.
Stearine Poste	=	1 lb.
Borax	=	1 lb.
Blue	=	at discretion.
Water	=	70 Gallons

(57) *Finishing Mixing—For Dhoties.*

Farina	=	20 lbs.
Soluble Starch	=	30 lbs.
Mineral white	=	3 lbs.
French chalk	=	6 lbs.
Cocoanut oil	=	4 lbs.
Glycerine	=	1 lb.
T. Red oil	=	1 lb.
Glucose	=	4 lb.
Japan wax	=	½ lb.
Borax	=	1 lb.
Ch. of Zinc	=	4 ozs.
Blue	=	at discretion.
Water	=	85 Gallons.

Boil 25 minutes.

(58) *Light Finishing Mixing—For Dhoty.*

China clay	=	30 lbs.
French chalk	=	4 lbs.
Mineral white	=	1 lb.
Epsom Salt	=	4 lbs.
Glycerine	=	8 ozs.
Japan wax	=	2 ozs.
Cocoanut oil	=	2 ozs.
Soap (Best)	=	2 ozs.
Turkey Red oil	=	8 ozs.
Ch. of Zinc	=	2 ozs.
Borax	=	at discretion.
Water	=	140 Gallons.

Boil for about 30 minutes.

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(59) *Heavy Finish—For Book cloth.*

Farina	=	50 lbs.
Amylose	=	25 lbs.
China clay	=	120 lbs.
Glue	=	17 lbs.
Cocoanut oil	=	5 lbs.
Ramasit I	=	5 lbs.
Water	=	70 Gallons.

Boil 30 minutes.

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(60) *Linen Finishing for the Padding Machine*

Amylose	=	75 lbs.
Soap	=	10 lbs.
Gelatine	=	$2\frac{1}{2}$ lbs.
Borax	=	$2\frac{1}{2}$ lbs.
Ramasit I	=	4 lbs.
Indanthren Blue RZ paste	=	$6\frac{1}{2}$ ozs.
Water	=	60 Gallons.

Boil 20 minutes.

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(61) *Light Finish—For Bandage cloth.*

Farina	=	10 lbs.
Maize Starch	=	40 lbs.
China clay	=	15 lbs.
Epsom Salt	=	15 lbs.
Cocoanut oil	=	1 lb.
T. Red oil	=	1 lb.
Water	=	70 Gallons.

Boil for about 80 minutes.

(62) *Light Finish—For Bandage cloth.*

Turkey Red oil	=	2 lbs.
Methylene Blue	=	Sufficient for a tint.
Water	=	70 Gallons.

Boil 10 to 20 minutes.

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(63) *Light Finish—For Napkins or Small face Towell.*

Sago Flour	=	2 lbs.
Maize Starch	=	8 lbs.
Soluble Starch	=	2 lbs.
Farina	=	2 lbs.
French chalk	=	10 lbs.
Cocoanut oil	=	4 ozs.
Stearine Paste	=	2 lbs.
Paraffin wax	=	1lb.
Blue	=	at discretion.
Water	=	70 Gallons.

Boil for about 30 minutes.

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(64) *Light Finish—For Mosquito Net.*

Maize Starch	=	15 lbs.
Farina	=	25 lbs.
Dextrine	=	10 lbs.
Soluble Starch	=	5 lbs.
Rice Starch	=	2 lbs.
Gum	=	3 lbs.
Glucose	=	5 lbs.
Paraffin wax	=	5 lbs.
Mutton Tallow	=	5 lbs.
China clay	=	20 lbs.
Blue	=	as required.
Water	=	70 Gallons.

Boil about 30 minutes.

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(65) *Light Finish—For Mercerised dyed goods.*

Dextrine	=	100 lbs.
Sago	=	25 lbs.
Farina	=	10 lbs.
T. Red oil	=	5 lbs.
Mercerine glaze	=	5 lbs.
Water	=	70 Gallons.

Boil for about 30 minutes.

(66) *Light Finish—Fancy Coating cloth.*

Farina	=	30 lbs.
Wheat Starch	=	40 lbs.
Soluble Starch	=	10 lbs.
China clay	=	20 lbs.
Epsom Salt	=	20 lbs.
French chalk	=	5 lbs.
Mutton Tallow	=	2 lbs.
P. Wax	=	2 lbs.
T. Red oil	=	5 lbs.
Water	=	70 Gallons.

Boil for 30 minutes.

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(67) *Light Finish—For Twill S. Coating cloth.*

Maize Starch	=	60 lbs.
Farina	=	30 lbs.
Rice Starch	=	5 lbs.
French chalk	=	50 lbs.
Epsom Salt	=	50 lbs.
P. wax	=	5 lbs.
Tallow	=	5 lbs.
Glucose	=	3 lbs.
Stearine paste	=	3 lbs.
Water	=	70 Gallons.

Boil 30 minutes.

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(68) *A Finishing Recipe* for Hand made cloths.*

Rice	=	9.6 ozs.
Milk	=	9.6 ozs.
Alum	=	6.0 ozs.
Water	=	10 Gallons.

Water is boiled first with rice, and to the size prepared thus after it cools, a little milk is added. Then in small quantities the mixture is taken out according to daily requirements. Supposing half a gallon of size mixture is taken for use, then 4 oz. of alum powder is added to it.

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*From Department of Industries Bulletin No. 21 of 1926 issued in Madras.

Notes on Finishing;—As a general rule the finer the cloths the less the china clay and minerals are used and the mixing paste is made thinner by adding water. Clay is used when bright finishes are wanted and mineral for dull finishes. The best way to produce a particular kind of finish is to run a piece or two through and to regulate the weights on the mangles by the result obtained with these pieces. As regards stiffening the following points may be mentioned, the greater the pressure there is on the mangle the less stiffening is put into a cloth. but on the other hand it helps the stiffening to penetrate into the cloth and does not leave it on the surface to dust off when dried up. The steam pressure should be watched when preparing finishing mixing. There should be a steam trap near the size preparing becks to prevent too much condensed water finding its way into the mixing.

Modern Finishing Agents.

In recent years a variety of entirely new finishing agents has been introduced into the market. These products are for the most part based on modern synthetic resins, cellulose derivatives and synthetic fatty bodies of highly complex structure. Many of these products have been designed to produce finishes which are very much faster to washing and dry cleaning treatments than the usual finishes involving the use of starches, gums, glues, soluble oils, etc. Others of these products although not producing finishes which are faster, nevertheless give new and novel results which have not before been attained. These products, therefore, represent entirely new additions to the finishers' art. Although introduced only within recent years, they have already found a number of applications and their use in the future is likely to increase considerably.

Products Producing Resistant Finishes.

Bedafin D.

Bedafin D is a concentrated emulsion of a thermoplastic synthetic resin, which need only be diluted with water to the desired concentration for application to fabrics. Goods padded through this solution and dried above 140°F acquire a full flexible handle which is resistant to mild washing treatments. The product is particularly suitable for finishing artificial silk and spun rayon piece goods. By dispersing a pigment in the Bedafin D liquor it is possible to obtain a pigment finish which is fast to mild washing. Emulsified synthetic resin products of this type are likely to become very common in the future.

Bedafin E & Bedafin F.

Bedafin E and Bedafin F are two products which have to be applied to fabrics from a solution in Trichlorethylene or a mixture of Toluene and Etyl Alcohol. By passing fabric through a solution of these products in the above organic solvents and drying above 140°F, stiff finishes are produced which are fast to washing. These resins are also used for re-stiffening dry cleaned garments from solution in Trichlorethylene, sind dry cleaned garments unless properly restiffened are liable to be flabby in handle.

A Plasticiser may be incorporated into the solutions of the resins in order to soften the finish produced.

Bedafin 2001.

Bedafin 2001 is a thermohardening synthetic resin product which can be dissolved in water by the use of Ammonia or Triethanolamine. By impregnating fabrics with such a solution, drying and then heat treating the dry fabric for a few minutes above 100°C (212°F), full stiff finishes are produced which are very resistant to washing and to dry cleaning treatments. If pigments are included in the impregnating solution., pigmented finishes are produced which are again fast to washing. The product may also be used for producing fast to washing pigment prints, and glazed chintzes.

Method for using Bedafin 2001.

The following is a typical formula for dissolving Bedafin 2001 :—

10 lbs. of Bedafin 2001 (approximatly 1 gallon) are added with stirring to a solution of ½ pint Ammonia (0.910) in 2–3 gallons cold water. The smooth paste thus obtained can be diluted to any required volume by mixing with water. The solution should not be heated above 160°F (70°C).

Method of application.

The fabric to be filled or softened is padded in a solution of Bedafin 2001 at 65–120°F. The treated cloth is then squeezed and dried. If a finish fast to washing and dry cleaning is required, the dry material should now be heated for 3–4 minutes at 260°F or 10–15 minutes at 212°F. The heating is best carried out by passing the goods through a heating chamber fitted with rollers or by passing several times round cylinders at 230–250°F.

Concentrations of 5–10% give a sufficiently stiff handle for most purposes. For fullness without much stiffness concentrations of $\frac{1}{2}$–2% are recommended.

Bedafin 2001 has so far proved particularly useful for giving a full handle to low quality materials such as low quality suitings, shirtings, book–cloths and furnisnhing materials. Since it gives increased resistance to wear, it is a valuable product for treating drills and other fabrics for overalls.

If the Bedafin 2001 finish should be too stiff it may be softened by plasticizing with Bedafin 285X, a fully polymerised, soft, oily, synthetic resin.

It is interesting to note that Bedafin 2001 may also be used for improving the fastness of mechanical finishes to washing and for the production of washable glazed chintzes.

Cellofas TAF

Cellofas TAF is a cellulose derivative which dissolves in Caustic Soda. Cloth treated with a Caustic Soda solution of Cellofas TAF and then subsequently passed through a dilute solution of Sulphuric Acid or a solution of Sodium Chloride and finally washed and dried acquires a very full, firm, flexible handle which is fast to washing treatments.

Details of method of application of cellofas TAF

The following are details which are given for the use of these products :

15 parts of water wet Cellofas TAF are added to 85 parts of 17°Tw. Caustic Soda and stirring is continued until complete solution is obtained. The liquor can now be diluted with water to any desired concentration. Cellofas TAF may be applied on ordinary textile machinery but it should be noted that the bowls with which the fabric is squeezed should be made only of iron, steel, rubber or vulcanite or wood. For fixing Cellofas TAF on the cloth, the impregnated material should be treated in a 3–5% solution of Sulphuric Acid. A concentrated solution of Sodium Chloride may also be employed in the place of Sulphuric Acid. After the fixation treatment, the cloth is thoroughly washed, dried and finished in any suitable manner. Fillers such as China Clay, Barium, etc. can be included.

The finishes produced by Cellofas TAF are not only very resistant to washing but also possess increased strength and resistance to abrasion.

The above are one or two examples drawn from the increasing range of products which are suitable for production of resistant finishes on cotton. Below are given a few examples of resin products which although giving finishes of indifferent resistance to washing., etc. are characterized by producing new types of handle.

For instance *Bedafin A*, a product which can be dissolved in water by the use of Ammonia or Triethanolamine, is representative of a class of new materials which produce fulness and softness of handle simultaneously without producing stiffness. Such a product is of course very useful for finishing a wide variety of fabrics. The application of Bedafin A is simple, it being only necessary to impregnate the fabric, squeeze and dry in order to obtain a supple, soft finish. The product has been found particularly suitable for application to cotton goods which are to be subsequently beetled or schreinered, a full and plump velvety handle being given to the goods. Bedafin A is an excellent finishing agent for spun rayon fabrics and knitted rayon fabrics.

Bedafin HN is another water soluble synthetic resin product which was developed for use in hatting trade to replace Shellac–Borax emulsions for stiffening and proofing wool and for felt hoods. Apart from this application this product has been found to be a useful addition to finishing mixtures for improving the fullness and stiffness of the resultant finishes.

Resistant Finishes Based on Fatty Bodies.

In addition to the materials based on synthetic resins and cellulose, other products have been introduced in recent years which are based on fatty bodies and which also produce finishes with resistance to washing. One of the most interesting of these is Velan PF.

Velan PF

Velan PF when applied to cloth by a special process, has the remarkable property of producing a shower–proof finish which is resistant to washing and to dry cleaning treatments. It can also be used for producing permanent soft finishes. The product is applicable to all types of fabrics including cotton, rayon, spun rayon, silk, wool, etc.

Up to the present, all the shower proof finishes on fabrics have been produced by the use of Aluminium Salts such as Aluminium Acetate by Aluminium Soaps, by Waxes i.e. Paraffin Wax, etc. or by modern emulsified preparations such as Waxol W. All of these finishes possess a major disadvantage, that they are readily destroyed by washing and dry cleaning treatments. Fabrics, therefore, proofed by any of these methods always require re-proofing after cleaning. The advantage of "finish such as they produced by Velan PF, which is not destroyed by cleaning, is obvious.

(*Note* : Under the heading "Shower Proof Finishes" completely waterproofed materials such as rubberized fabrics and "oil skins" are not included, since these come into a different category altogether.)

A further interesting advantage which is claimed for Velan PF is that fabrics shower-proofed by this material are soft and flexible, unlike fabrics showerproofed by other processes which tend to be somewhat stiff and hard.

The Velan PF Process.

Briefly, the method of application of Velan PF consists of the following stages :—

1. Impregnation of the fabric in an aqueous solution of Velan PF containing Sodium Acetate.

2. Drying of the impregnated fabric.

3. Heat treating the dry fabric for a few minutes above 100°C (212°F).

4. Washing the treated fabric in a liquor containing soap and soda ash, rinsing and drying.

Velan PF is dissolved by pasting it with 3% of Methylated Spirit (calculated on the total volume of solution) and then diluting the paste with water at 100°F to the desired concentration. A portion of the diluting water should contain an addition of crystalline Sodium Acetate equal to one-third of the weight of Velan PF used. In use the solution of Velan PF should not be heated above 100°F, since Velan PF in solution is unstable above this temperature. For good water repellency on cotton cloth, 4–6% solutions are generally used (4–6 lbs. per 10 gallons solution).

Application of Velan PF

For application of solutions of Velan PF any normal textile machinery used for impregnation may be used although a padding mangle is the most convenient machine. The bowls of the padding mangle should for preference be constructed of rubber, wood or stainless steel.

The impregnated material must now be dried as quickly as possible bearing in mind that Velan PF is unstable to the combined presence of high temperatures and excessive moisture. Temperatures varying from 120°F up to 212°F have been used successfully for drying fabrics impregnated with Velan PF, the higher the drying temperature the more quickly the fabrics being dried. For instance at 120°F the fabrics may be dried in a good air draught over a few hours, whereas at 212°F the fabrics should be dried in about 1 minute in a good air draught. When drying on tins, the first four tins should be lapped.

The dry material is heat treated for 5 minutes at 130°C (266°F) or 1½–2½ minutes at 150°C (302°F).

The dry heat treated material is now waterproof; but to produce the maximum effect, it should be given a washing treatment in a liquor containing 2–3 lbs. of soap and 1 lb. of Soda Ash, per 100 gallons at a temperature of 50–60°C, (120–140°F) followed by thorough rinsing and drying at a temperature above 180°F.

It should be noted that all materials before treatment with Velan PF should be pure, i.e. they should contain no other finishing agents such as starch, glues, gums, wetting out agents, softening agents, etc.

This shower proof finish, resistant to washing and to dry cleaning, can be produced by the method noted above on cotton goods of all descriptions. Not only is the product useful for treating the usual types of cotton fabrics such as gaberdines, poplins and canvas which are used for rain proof fabrics; but may also be used with advantage on dress materials where its water repellent properties give increased resistance to staining.

Velan PF for soft Finishes.

Apart from its shower–proofing properties, Velan PF when used at very low concentrations is a very powerful softening agent for all types of fabrics including cotton and rayon materials. For the production of resistant soft finishes, it is unnecessary to go through

the more complicated process outlined above., impregnation and drying being all that is necessary. Concentrations of Velan PF varying from ¼ to 1 lb. per 100 gallons may be used. For production of soft finishes, the Velan PF is pasted with a little water at 40°C (100°F) and is then diluted with cold water to the required volume. The final solution must be used cold and should on no account be warmed. The fabrics to be softened are worked in the cold solution fo 10–15 minutes in the usual way and then squeezed and dried. The finish thus produced is particularly soft and if drying has been carried out at a temperature above 160°F the finish also possesses very considerable resistance to washing, etc.

CHAPTER XLVI.

CALENDERING.

The object of calendering cotton piecegoods is, to close the threads of cotton abrics by flattening them out, and imparts to the cloth the gloss or feel required.

Fabric Appearance Changed.

Fabrics in the grey state when calendered are stretched to full width, the weft are pulled square with the warp, straightens the selvedges, smoothens and evens the cloth, removes all wrinkles, and imparts a dead flat finish to the pieces and thus the appearance or look of the fabric is changed without the addition of any ingredients, with the exception of the size added to the warps in the process of sizing before weaving, and sometimes a certain amount of moisture is added from a damping machine before calendering.

The finish produced by a calender depends chiefly on the composition and arrangement of the bowls, the pressure and the temperature of the bowls, and the moisture in the cloth. Calenders are constructed in many different forms with from two bowls to ten bowls according to the finish and output required and the class of fabric undergoing treatment. The cloth passes between rollers under heavy pressure, one of the rollers, is of highly polished metal (usually Steel) and the other cotton compressed very hard. The polisher roller is heated by steam or by gas. Usually more than two rollers are present on the same machine, and the cloth receives several "Nips."

Bowls may be divided into two types ;—Bowls made of compressed material and metal bowls. Bowls of compressed materials can be sub-divided into two types, viz. compressed cotton and compressed paper.

The calender bowls are therefore made of steel chill, iron, brass, cotton, paper and wood.

Compressed cotton Bowls, are made of fine Egyptian cop bottom waste suitably carded and pressed under heavy hydraulic pressure into a solid on a steel centre Shaft and held in this condition by strong steel end plates. For many finishes cotton bowls are preferred. The degree of hardness to which the cotton is pressed depends on the finish for which the bowl is required.

Compressed Woollen Paper Bowls, which are composed of paper made of woollen rags specially selected to whithstand pressure and heat, are made under conditions similar to cotton bowls. Papers made of other materials, such as linen, cotton and flax, are also used though for general purposes woollen paper is the most usual, especially for the finishing of ordinary cotton fabrics.

Metal Bowls, are constructed of chilled iron or close grained cast iron or steel. The chilled-iron bowl are made with a highly-polished hard surface. They are usually hollow and heated with steam or gas from inside. Where a high temperature is necessary gas is preferred. The bottom bowls of calenders are usually made of close-grained cast iron, and the driving bowl of the calender is usually a chilled-iron bowl.

Frames for supporting the bowls are constructed in either closed or open form. The closed frame is fitted with a loose cheek which must be removed when it is required to take out any bowl from the calender. The open frame is so designed that the bearings supporting the bowls have an open front so that each bowl may be removed from the calender without dismantling any part of the frame and without disturbing any other bowl. Except in special cases, as in the heavy 3-Bowl Friction Calender, the open type of frame is almost universally adopted in all modern finishing works owing to its convenience.

The bearings of open type frames should be lubricated by rings and totally enclosed. They should be proof against the entry of dirt and the escape of oil from the bearings, and should have sufficient bearing surface to keep the bearing pressure low. The ring-lubrication system must be carefully designed, and should maintain a film of oil round the neck of bowl under all conditions. Compound levers and weights are used to give pressure to the bowls, or hydraulic pressure may be used, as on the Schreiner Calender.

Wood bowls are the safest, and are used for soft finishes, such as sateens and piques, etc. They leave the goods fuller than any other kinds of bowls. Paper is harder than cotton and leaves the goods finer and lighter in appearance. Metal bowls are used for bright finishes, leaves the goods much more lustrous and with finer face than paper bowl. Certain effects, such as Schreinreising, moire-lusting, embossing, and watering are produced by calenders of special forms. In using friction to produce certain finishes, it is very important to regulate the weight or the pressure on the bowls to the quality of cloth passing through, remembering that if the pressure

to too great the cloth is very liable to be torned or otherwise damaged. If the amount of the friction is too great, that is, if the friction bowls revolves too quickly in proportion to the speed of the other bowl, then the liability to damage is much increased. The remedy is obvious, reduction of pressure in one case and reduction of speed by altering the gearing wheels in the other.

Glazing is the term used when a gloss or lustre is given to the cloths. It is produced by using a calender with a finishing polish. Steel bowl that can be heated by steam passing through it or by other means. Swizzing is now taken to indicate calendering lightly without pressure on a three-bowl calender. The finishes required to be obtained by means of the calender are many and varied, as are also the types of calenders made to produce them.

A finisher who knows his business well, however, can produce many different finishes from one 7-bowl calender, especially fitted with friction gearing. The cloth should run from a pile or fold, and plait them down upon leaving the calender on a bench or tightly batched.

In the class of finish where high glaze and heavy closing of the threads is required, the cloth comes in contact with a polished, heated, chilled-iron bowl, which is travelling at a faster speed than the cloth.

Frictioning to Intensify Polish or Lustre.

A 3-Bowl Heavy Friction Calender of massive construction, is suitable for highly-glazed linings, prints, tracing cloth, book cloth, window-blind cloth, grey dhooties, etc.

The top bowl, which is the glazing bowl, is highly polished chilled iron heated by steam or gas, and should be of sufficient diameter to avoid deflection under heavy pressure. The middle bowl is usually made of cotton, and is of large diameter to allow for wear. The bottom bowl is of close grained cast iron. By an arrangement of Spur wheels the bottom bowl is geared to run at a slower speed than the top bowl. The ratio of lineal speed varies usually between 1 : 5 up to 2: 1, though for certain qualities of cloth, as, for example, book cloth, the friction ratio may amount to as much as $3\frac{1}{2}$: 1. The cloth is passed first through the bottom nip and round the middle bowl, which moves at the same lineal speed as the bottom bowl. The top bowl revolving on the cloth at the higher speed gives the friction effect.

For very ight friction on grey cloths and coloured woven cloths, a calender with two cotton and a middle steel bowl is used. The bottom two bowls are geared together so as to give a slight friction. This calender gives a slightly more polish than can be obtained by swizzing only.

Swizzing Finishes are obtained by passing the cloth through the nips of the calender in which the lineal speed of all bowls is the same, and batching or plaiting down. The cloth thus receives a smooth appearance and gloss but without the high glaze characteristic of frictioning.

Chasing Finishes are obtained by passing the cloth through the nips of the calender and over external rollers and back into the bottom nip of the calender. The cloth is led through the calender several times, each layer of cloth lying over another. Chasing gives the cloth a thready linen appearance and a special soft handle with a slight watermark effect.

Schreinered Finish—The lustre on the fabric that has been Schreinered has been obtained by pressing it with heavy rollers cut with fine lines. These lines are visible when the cloth is examined through a magnifying glass.

Beetle Finish.—The yarns are seen to be flattened out into a fine tape instead of being round.

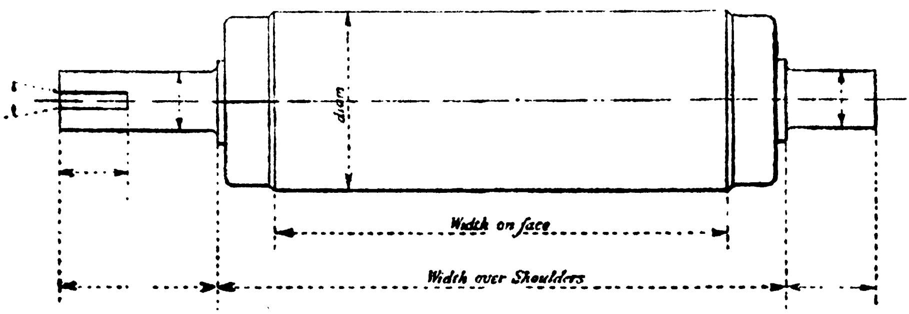
Before entering the calender, the pieces are threaded to run under and over a number of strong scrimp rails, in order to put tension upon them when entering the machine and also to enable the operative to open out the goods to prevent creases and curled selvedges entering the nips.

If heavy pressure is to be applied to the bowls, all the sewings must be taken out of the piece, and the ends carefully pasted together in order to form a smooth joint which will not damage the bowls. Care must also be taken to prevent excessive wear of the softer bowls taking place, the cloth must not always be run through the nips in the same place.

One lot of goods should be run through near to one end of the bowls, and the next as far to the other side as posible, when the calender is likely to be out of use for sometime the prssure must be taken off the bowls, otherwise the paper or cotton bowls will become flattened out where they have been in contact with the steel or iron ones. The machine should not be allowed to run empty for any

length of time, especially when the bowls are heated, as this would scorch the cotton or paper bowls and cause them to become dirty. If the bowls should become dirty they should be washed down with soap and water, but care should be taken not to allow the paper or cotton bowl to become too damp. One half of the calender must be washed first and, when dry, the other half. The reason for this is that if the bowls are wet across their full width they will not grip; the driving bowl will be moving but the bowls above and below will be stationary.

Great care must be taken to lubricate the necks of the bowls to keep them as cool as possible, and to avoid oil and grease used for this purpose from spreading on to the face of the bowls, otherwise the bowls are bound to be destroyed very fast, suet is sometimes used in place of oil or grease.



Details of dimensions to be given
when ordering a new
Calender bowls.

General Hints For Using Calender Bowls.

(1) As little as possible of the bowl surface Should be left uncovered by cloth at each end of the bowl.

(2) If running with "Narrow goods on a wide machine," the cloth should be shifted to and fro as often as possible. Better still, the bowls should not exceed the widest cloth being woven by more than 4 inches, that is, 2 inches on each side if the bowls are to last for a long time.

(3) All bowls should be examined at least once a week, and if the ends show signs of swelling they should be scraped down with suitable hand scraper. If this point is overlooked the cotton will burst out.

Calender bowl ends should be tapered down once a week, or once a fortnight as it may be found necessary if the bowls are to be saved from getting ruined soon. Cotton bowls have a tendency to get hollowed out at the centre through constant use, and, required periodical scraping of the ends to obviouviate this tendency. New bowls, if slightly barelled, say 1/32" from the centre right to either end, are preferable to those tapered only a few inches from the end, because the former gives a convex formation to the bowls, which has a lesser tendency to concavity, and consequently last longer without affecting the calendering of the cloth.

(4) It is a good plan, when running "narrow goods," through a wide calender, to plug up with red-lead the holes in the gas heater which heats the surface of the bowl not covered by the cloth.

(5) See that the pressure is the same on both compound levers. In all calenders see that the pressure is the same at both ends, otherwise the bowls will become tapered and the cotton loose in the centre.

(6) In "dead set" calenders, such as friction calenders, the set must be put on evenly before applying the final pressure; this is usually done by hand wheels on top of the calender frame. A new bowl may be ruined in a few minutes by neglect of this.

(7) When a "new bowl" has been placed in a calender it should be run without cloth until a good hard surface is obtained. This may take several days.

(8) When the calender is stopped temporarily the compound pressure must be relieved. This is done by the cams and hand levers. At night and week-ends the worm and worm wheel setting down motion should be used to raise the bowls until they are separated.

(9) The face of cotton bowls must be kept free from grease or oil.

(10) Bowls should be kept in a dry place when not in use. Damp is a frequent cause of bowl trouble.

(11) The chilled iron bowls must not be heated when the cotton bowls are not revolving otherwise the cotton bowls will be burnt.

(12) Sometimes the chilled iron bowls are worked with high pressure steam. This is dangerous in the first place, and secondly results in excessive temperature and burning of bowls. The steam pressure should be regulated from 3 to 10 pounds according to class of work.

(13) In order to lengthen the life of cotton bowls in large calenders the lowest cotton bowls should be taken out after two months working and placed at the top of the calender and the top cotton bowl should take its place. The other cotton bowls should be moved in a similar way.

Washing of Cotton Bowls.

(14) Before commencing to wash the bowls turn off the steam or gas supply on the heater and allow the metal bowls to cool.

(15) The metal bowl should be sufficiently cool to touch with the naked hand before commencing washing. During washing, the temperature should be kept constant by turning the heater on again.

(16) Remove pressure whilst the "bowls are cooling." Whilst washing up the bowls the pressure should not be more than "half working pressure."

(17) If the suràce of a cotton or paper bowl "has been broken", it must "not be washed" until the surface has been made good in the lathe.

(18) Best quality soft soap and water should be used for washing cotton bowls.

(19) Cotton bowls should always be kept sufficiently clean also all the parts of the calender machine itself too. The man in charge of the calender machine should take a pride in it by keeping it perfectly clean.

(20) Excessive tension before feeding the cloth to the calender bowls will affect the width up to 3 inches particularly if the cloth is damped with a solution of starch, etc.

(21) Putting tension on the cloth at feeding end of the folding machine will also affect the width of cloth from ¼ to ½ inch.

(22) The shrinkage of sarees or dhoties can be regulated on the calendering machine if the cloth is properly passed over and above the wet steam and then the expanders.

(23) The steam must be well regulated as the moisture contents on the cloth, before it is calendered, is a big factor in controlling the width of the fabric.

(24) The constant feed of the cloth, constant temperature of the iron bowls and the pressure on them are very important factors for regulating the width of the cloth.

(25) Freshly turned bowl with a marked convexity also affects the width of the cloth, but gives better calendering results.

(26) The drag imparted to the cloth through the temperature rails should always be less for the fine cloth than for the coarse.

(27) The method of joining the ends of pieces, in case of fine count cloths by sewing them on a sewing machine, is not ideal, though workable, the correct way being to join the ends by some form of pasting them together.

(28) Another important factor, which affects width and lengths variation in the same piece, is the method of piling the cloth at the feed of the calender, or the formation of the cloth roll containing the damped pieces. A pile or roll should have a straight edge free from overlaping selvedges, because any deviation from an even formation imparts a zig zag and wavy action to the cloth, in spite of the guide rails, as it is delivered to the calender. This creates a differential milling up between the bowls.

(29) A difference in the milling up also takes place if there is a slight, though imperceptible, lateral movement of the bowls either due to inaccurate level, or due to the wear of the bowl brasses, especially where single piece old type brasses are used, wedge-shaped brass holders always keep the brass in contact with the bowl pins and require less attention and help the bowls to rotate truly.

(30) To give a good solid lustre on grey cloth very heavy calenders are required, otherwise it will be found necessary to calender the pieces two or 3 times on a 3-bowl friction calender to get the desired lustre. It is especially the case with coloured goods particularly the black dyed cloth. But it is possible to get good lustrous effect on dyed cloth by calendering only once if the cloth is damped previous to calendering by an appropriate damping mixing.

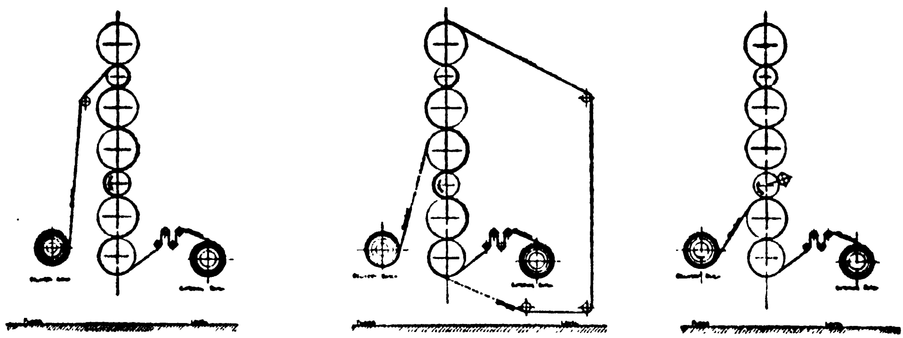
(31) Ingredients used in sizing and filling, such as Epsom salts, have a tendercy to diminish the sheen after calendering, and this has to be allowed for.

(32) Many goods require a high friction finish, and if they have been heavily sized with much china clay in the mixture, the cloth may pluck in the nip.

(33) Before starting up a calender, see that the driving bowl is level and the side brasses are in proper positions.

(84) In some quality of Long cloth or Horrocks Bleached or Unblached it is necessary to meet the requirements of the dealer with regard to a peculiar feel and sheen to first calender it through 7 or 10 bowls and then through 3 bowls if lustre is required and vice versa if no lustre is required. In some cases steam should be given and in other cases no steam or very little steam should be given in the steam box. Ofcourse the pieces must be damped before calendering either with water only or a mixture prepared for the class of goods that is being calendered.

Calenders with more than three bowls are usually designed to give friction, chasing and swizzing finishes, and are called universal calenders. The method of threading the cloth through a 7-bowl Universal calender, to give various finishes, is sho wn below.



The arrangement of Bowls in a 7-Bowl calender may be as follows.

A. (1) Bottom close-grained iron.
   (2) Compressed cotton.
   (3) Polished chilled iron, steam-heated; the driving bowl.
   (4) Compressed cotton.
   (5) Compressed cotton.
   (6) Polished chilled iron, steam-heated.
   (7) Top compressed cotton.

B. (1) Bottom close-grained iron.
   (2) Compressed cotton.
   (3) Polished chilled iron, steam-heated, the driving bowl.
   (4) Compressed cotton.
   (5) Polished chilled iron, steam-heated.
   (6) Compressed cotton.
   (7) Top compressed cotton.

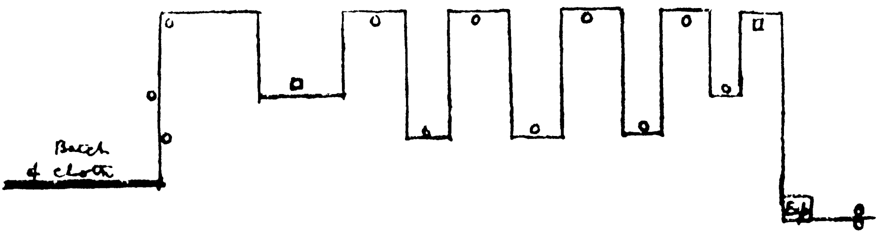
Hydraulic Calenders.

Hyderaulic power 's a convenient method of applying pressure to the bowls of calenders, and is used frequently where it is desirable to apply and release, instantaneously, the pressure between the bowls.

The arrangement of bowls varies, but one of the ways is as follows :—

(1) Bottom cotton.
(2) Chilled iron, steam-heated.
(3) Cotton.
(4) Cotton.
(5) Cotton.

A Tension Arrangement.



0 = Roller.
□ = Stay sq. rod.
Exp. =Expanders.
00 = Calender bowls.

The above arrangement gives very satisfactory result if made at the feeding side of a calendering machine.

Damping.

It is usual to damp the cloth, before calendering, to produce the maximum lustre handle or feel. This can be done by either brush or spray damping machine, or by fixing a steam box in front of the calender. The brush spray is preferable. Damping is not always necessary and should be avoided, if possible, as it brings in the width. This involves the process of stretching when a good width is required. Should a maximum lustre be required, damping cannot be avoided,

and it must be added that the feel of the cloth is improved after calendering. On the other hand, certain well-filled goods, after well damping and calendering, become caky. A steam box in front of the calender, can only damp the surface of the cloth, and in the case of heavily sized or filled goods, much of the clay and starch mark off on to the bowls. Water should not be forced into the cloth indiscrimately or faults will occur. There should be no wet marks on the pieces when damped. When the goods are correctly damped, they should heat up in an hour or so. All goods damped should be allowed to remain in piles at least overnight so that the maximum amount of regain is realised.

Faults.

Faults are:—Pieces too wet; uneven damping. An alternative damping method is by a conditioning machine consisting of pairs of rollers, the .lower one engraved and welted.

CHAPTER XLVII.

DAMPING MIXINGS.*

I.	Maize Starch	=	5 lbs.
	Farina	=	3 lbs.
	Sago Flour	=	2 lbs.
	T. Red oil	=	1 lb.
	Soap (best quality)	=	1 lb.
	Cocoanut oil	=	2oz.
	Ch. of zinc	=	2 ozs.
	Water	=	100 Gallons.

Boil 20 minutes.

II.	Wheat Flour steeped	=	1 lb.
	Sago Flour	=	2 lb.
	Farina	=	2 lb.
	Soap	=	1 lb.
	T. R. oil	=	1 lb.
	Epsom Salt	=	4 ozs.
	Cocoanut oil	=	2 ozs.
	Water	=	50 Gallons.

Boil 20 minutes.

III.	Maize Starch	=	1 lb.
	Sago Flour	=	8 lbs.
	Rice Starch	=	1 lb.
	T. Red oil	=	1 lb.
	Soap (best quality)	=	1 lb.
	Glycerine	=	2 ozs.
	Water	=	100 Gallons.

Boil 20 minutes.

IV.	Sago Flour	=	4 lb.
	Maize Starch	=	2 lb.
	Farina	=	2 lb.
	Rice Starch	=	1 lb.
	Wheat Flour	=	1 lb. (Steeped with Zinc.)

* May be used for grey or coloured goods.

Cont:

Cont:

	Soap (best quality)	= 1 lb.
	Cocoanut oil	= 2 ozs.
	Glycerine	= 2 ozs.
	Borax	= 1 lb.
	Japan wax	= 4 ozs.
	Water	= 50 Gallons.

Boil about 20 minutes.

V.	Farina	= 3 lbs.
	Rice starch	= 2 lbs.
	Sago Flour	= 5 lbs.
	T. Red oil	= 1 lb.
	Soap (best quality)	= 1 lb.
	Cocoanut oil	= 2 ozs.
	Water	=100 Gallons.

Boil 20 minutes.

VI.	Soluble Starch	= 5 lbs.
	Sago Flour	= 5 lbs.
	T. Red oil	= 1 lb.
	Soap (best quality)	= 1 lb.
	Japan wax	= 2 lb.
	Borax	= 8 lb.
	Water	=100 Gallons.

Boil 20 minutes.

VII.	Rice Starch	= 3 lbs.
	Farina	= 3 lbs.
	Sago Flour	= 2 lb.
	Soluble Starch	= 2 lb.
	T. Red oil	= 1 lb.
	Soap (best quality)	= 1 lb.
	Japan wax	= 2 lb.
	Borax	= 8 lb.
	Water	=100 Gallons.

Boil 20 minutes.

VIII.	Sago Flour	= 3 lb.
	Maize Starch	= 3 lb.
	Farina	= 1 lb.
	Rice Starch	= 2 lb.
	Wheat Flour	= 1 lb. (Steeped with Zinc.)

Con:

Cont:

Soap (best quality)	= 1 lb.
T. Red oil	= 1 lb.
Salomoniac	= 8 ozs.
Alum	= 8 ozs.
Cocoanut oil	= 2 ozs.
Glycerine	= 2 ozs.
Borax	= 1 lb.
Japan wax	=4 ozs.
Water	= 50 Gallons.

Boil 20 minutes.

IX.

Starch (Wheat)	= 10 lbs.
Amylose	= 5 lbs.
Ramasit I	= 5 lbs.
Igepony T.	= 1 lb.
Turkey Red oil	= 1 lb.
Pine oil	= 8 ozs.
Glycerine	= 1 lb.
Cocoanut oil	= 1 lb.
Japan wax	= 2 lb.
Borax	=2 lbs.
Salisylic acid	= 2 ozs.
Water	=100 Gallons.

Boil 20 minutes.

X

Sago Flour	= 6 lbs.
Farina	= 4 lbs.
Epsom Salt	= 2 lbs.
Turkey Red oil	= 1 lb.
Soap (best quality)	= 1 lb.
Borax	= 5 lb.
Stearine Paste	= 8 ozs.
Japan wax	= 2 lb.
Paraffin wax	= 8 ozs.
Cocoanut oil	= 8 ozs.
Ch. of Zinc	= 4 ozs.
Water	=100 Gallons.

Boil 20 minutes.

XI	Rice Starch	= 6 lbs.
	Amylose	= 5 lbs.
	Ramasit I.	= 5 lbs.
	Turkey Red oil	= 1 lb.
	Soap (best)	= 1 lb.
	Cocoanut oil	= 4 ozs.
	Ch. of Zinc	= 2 ozs.
	Water	=100 Gallons.

Boil 20 minutes.

XII.	Sago Flour	= 6 lbs.
	Epsom Salt	= 3 lb.
	Salomoniac	= 1 lb.
	Alum	= 1 lb.
	Borax	= 2 lb.
	Japan wax	= 1 lb.
	Stearine paste	= 1 lb.
	T. Red oil	= 1 lb.
	Water	=100 Gallons.

Boil 20 minutes.

XIII.	Rice Starch	= 5 lbs.
	Wheat Starch	= 5 lbs.
	T. Red oil	= 2 lbs.
	Soap (best)	= 1 lb.
	Ch. of Zinc	= 2 ozs.
	Water	=100 Gallons.

Boil 20 minutes.

XIV.	Sago Flour	= 8 lbs.
	Maize Starch	= 2 lbs.
	Borax	= 2 lbs.
	Cocoanut oil	= 2 lbs.
	Stearine paste	= 1 lb.
	Water	=100 Gallons.

Boil 20 minutes.

XV.	Sago Flour	= 5 lbs.
	Farina	= 3 lbs.
	Maize starch	= 2 lbs.
	Borax	= 2 lbs.
	Epsom Salt	= 2 lbs.
	Cocoanut oil	= 2 lb.
	Paraffin wax	= 1 lb.
	Water	=100 Gallons.

Boil 20 minutes.

XVI.	Wheat Flour	= 1 lb. (Steeped with Zinc)
	Sago Flour	= 2 lb.
	Farina	= 2 lb.
	Soap	= 1 lb.
	Stearine (paste)	= 1 lb.
	T. Red oil	= 1 lb.
	Epsom Salt	= 4 ozs.
	Cocoanut oil	= 2 ozs.
	Water	= 50 Gallons.

Boil 20 minutes.

XVII. **For Black Dyed cloth**

	Farina	= 8 ozs.
	T. Red oil	= 1 lb.
	P. Wax	= 4 ozs.
	Borax	= 6 ozs.
	Cocoanut oil	= 2 ozs.
	Soap	= 1
	Black Dye	=1 to 4 ozs. (mixed with water as required)
	Water	= 10 Gallons.

Boil 20 minutes.

XVIII. **For Black Dyed Susi cloth.**

	Farina	= 2 lb.
	Wheat Flour	= 1 lb.
	Sago Flour	= 2 lb.
	Soap	= 1 lb.
	T. Red oil	= 1 lb.
	Stearine Paste	= 2 ozs.

Cont.

Cont:

Epsom Salt	=	4 ozs.
Cocoanut oil	=	2 ozs.
Borax	=	8 ozs.
Paraffin wax	=	8 ozs.
Water	=	50 Gallons.

Boil 20 minutes.

XIX. For Black Dyed cloth.

Soluble Starch	=	1lb.
Rice Starch	=	1 lb.
Sago Flour	=	1 lb.
Stearine Paste	=	4 ozs.
T. Red oil	=	1 lb.
Cocoanut oil	=	4 ozs.
Paraffin wax	=	1 lb.
Borax	=	1 lb.
Soap	=	4 ozs.
Gum	=	4 ozs.
Water	=	30 Gallons.

Boil 20 minutes.

XX. For Black Dyed cloth.

Paraffin wax	=	4 lbs.
T. Red oil	=	1 lb.
Soap	=	1 lb.
Cocoanut oil	=	8 ozs.
Stearine paste	=	$1\frac{1}{2}$ lb.
Borax	=	2 lb.
Water	=	15 Gallos.

Boil 20 minutes.

XXI. For Black Dyed cloth (heavy finish)

Sago Flour	=	2 lb.
Farina	=	1 lb.
Soluble Starch	=	2 lb.
Wheat Flour	=	2 lb. (Steeped with Zinc.)
French chalk	=	1 lb.
Stearine Paste	=	1 lb.
Soap	=	1 lb.
Paraffin wax	=	4 lbs.

Cont:

Cont:

Borax	= 1 lb.
Cocoanut oil	= 4 ozs.
Black Dye	= 2 ozs. (prepared in water).
Water	= 50 Gallons.

Boil 20 minutes.

XXII. For Black Dyed cloth (heavy finish).

Wheat Flour	= 1 lb. (Steeped with Zinc).
Farina	= 2 lbs.
Soluble Starch	= 1lb.
Light Size	= 2 lb.
Paraffin wax	= 3½ lb.
T. Red oil	= 1 lb.
Glycerine	= 2 ozs.
Cocoanut oil	= 2 ozs.
Soap	= 1 lb.
Borax	= 6 lbs.
Black Dye	=1 to 4 ozs. (prepared in water).
Water	=100 Gallons.

Boil 20 minutes.

XXIII. For Bleached Dhoties and Sarees for Lustre and Soft feel.

Japan wax	= 1½ lb.
Paraffin wax	= 1½ lb.
T. Red oil	= 1 lb.
Borax	= 1 lb.
Glycerine	= 1 lb.
Cocoanut oil	= 1 lb.
Soap	= 1 lb.
Pine oil	= 1 lb.
Stearine paste	= 1 lb.
Water	= 10 Gallons.

Boil 20 minutes.

XXIV. For Grey Dhoty and Saree.

Farina	= 2 lb.
Light Size	= 2 lb.
Wheat Flour	= 1 lb. (Steeped)
Sago Flour	= 1½ lb.
Gum	= 1 lb.
P. Wax	= 3 lb.
Borax	= 2 lb.
Cocoanut oil	= 8 ozs.
T. Red oil	= 1 lb.
Water	= 50 Gallons.

Boil 20 minutes.

XXV. For Grey Dhoty and Saree (3 Bowl friction calender).

Sago Flour	= 2 lb.
Farina	= 1 lb.
Wheat Flour	= 1 lb. (Steeped).
50% Size	= 2 lb.
Cocoanut oil	= 6 ozs.
Best Soap	= 1 lb.
Stearine paste	= 1 lb.
T. Red oil	= 1lb.
P. Wax	= 3 lb.
Borax	= 2 lb.
Water	= 50 Gallons.

Boil 20 minutes.

XXVI. For Grey Dhoty and Saree (3 Bowl friction) Boardy feel.

Sago Flour	= 4 lbs.
Maize Starch	= 1 lb.
Epsom Salt	= 8 ozs.
Cocoanut oil	= 4 ozs.
Gum	= 8 ozs.
T. Red oil	= 1 lb.
Soap	= 1 lb.
Borax	= 1 lb.
Paraffin wax	= 2 lb.
Stearine Paste	= 4 ozs.
Water	= 50 Gallons.

Boil 20 minutes.

XXVII. Very good for lustre for both grey and Fancy cloth.

Farina	=	1 lb.
Rice Starch	=	1 lb.
Cocoanut oil Soap	=	1 lb.
Stearine Soap	=	1 lb.
Borax	=	4 ozs.
Japan wax	=	4 ozs.
Pine oil	=	2 ozs.
T. Red oil	=	1 lb.
Water	=	50 Gallons.

Boil 10 minutes.

N. B.—The quantities of ingredients may be increased or reduced similarly in the case of water, according to circumstances such as condition of calender bowls, number of bowls, condition and type of damping machine, demand and requirements of the merchants. Any of the mixings given above is good for either grey or coloured goods,

It is very wise to try a mixing on a class of goods, results watched and noted and if necessary the changes should be made or another mixing tried and so on.

CHAPTER XLVIII.

FOLDING.

The pieces after being woven are conveyed to the folding department or warehouse by the weavers to be booked between 10 and 12 A.M. or any other suitable time. These pieces are booked for the purpose of knowing the quantity of cloth received, of each sort, and reported to the management; and for paying the weavers at the end of each month (or at the end of each fortnight) what they have earned, on their production. Each weaver has his production booked on a tally board.

Inspecting of Cloth.

The purpose of cloth-looking or inspecting is that of examining the cloth received from the weaver, with a view to detecting faults in the fabric and taking action to prevent a repetition of such faults. Other objects are to have any slight defects that the weaver may have left in the cloth removed if possible, and to put out or reject any piece that is not up to the standard of quality acceptable by the customer.

General Requirements.

The arrangement of machinery in the folding department should be such as to reduce to a minimum the handling of the pieces. There must be plenty of light in this department and must be kept very clear for the purpose of keeping the cloth free from getting soiled etc. Damaged and soiled pieces if allowed to get mixed up with fresh or good pieces and packed in a bale along with good pieces and packed in a bale along with good pieces, and sent out to the market will have a very serious consequence in as much as it will give the mill a very bad name and reflect on the management itself too. The mill is also apt to lose its business or trade or else undersale its product and thus bring upon itself heavy losses and grief.

Staff of Folding Department.

The number of looms, the width of cloth, the style of cloth, the reputation of the firm, local practice and other details determine the number of men required in the Folding Department.

Public must not be Deceived.

It is very unwise on the part of a manufacturer to stamp wrong widths or wrong length on the pieces; for instance, to stamp 44″ as the width of the cloth when it is actually 40″ wide.

It is both morally and legally wrong, and the mill, that practices such a thing, will find itself in the long run in a very serious trouble.

Defects to be looked For.

The length of the piece varies from 1 yard to 120 yards (for bleaching purposes) at the completion of a piece or cut which is indicated by a mark. The heading is inserted whenever it is required either on the loom or by hand in the warehouse or finishing department.

In the case of cloth for bleaching, dyeing, etc. no heading is inserted, though sometimes one or more cords are put in, if there are a range of the same quality, to distinguish one sort from another, at the end of three or five pieces of 23 yards each to save sewing labour and time in the next or following process.

After the cloths have been booked they are passed over to the folders who fold them on a plaiting or folding machine, and then pass them to the cut—lookers.

The defects to be looked for are Ends out, Mis-picks, Broken picks, Bad selvedges, Smashes or Traps, Thin and Thick places, Floats, wrong weft, shady weft, etc.

The pieces, if possible, are folded before calendering, so that faulty pieces may be detected before they are sent to be calendered, finished, etc. and theus prevent the pieces from getting soiled or mishandled, if they were to be inspected after they are calendered, finished, etc. The folded laps must often be checked during each day for the purpose of ascertaining the correct length of piece. If the fold is more than 36 inches, then the piece will have less folds, and it may be considered as a short length whereas actually it is not, and *vice versa.*

Hooking.

The old system of folding was called hooking. The usual arrangement for hooking consists of two stout wooden uprights attached to pillars or to a wall, and grooved to receive the ends of a

horizontal beam. The beam is adjustable vertically, and can be supported at the required height by pegs inserted in holes in the uprights.

The operator hooks one corner of the end of the cloth on the spur of a hook and then pushes the latter hook against the horizontal beam. The same selvedge of the cloth is now held horizontally, with one hand just under the other square shaft, and a hook is brought forward and then pushed against the beam by the other hand, the cloth being pulled over on the spur about ¼ inch from the edge. This operation is repeated alternately at the two sets of hooks in the upper beam until the whole cut is plaited, taking care to suspend the cloth on the hooks at an equal distance from the selvedge all through the cut.

Plaiting on Convex Tables.

The principal advantage of this type of table for a folding machine is that its surface is parallel to that of the arc described by the folding blades, as the swinging levers move to and fro. To prevent the cloth being carried back on the return stroke of the blade, grip rails are provided under which the cloth passes in completing the fold. This may be done either by causing the grip rail to lift slightly as the cloth passes under, or by causing the table to fall slightly, with a similar result. On the completion of each fold the grip rail is lowered, or the table raised, thus holding the cloth securely while the next fold is being laid on the opposite direction. Plaiting machines also act as measuring machines, since it is only necessary to count the number of folds, and to multiply this by the known length of fold, to ascertain or check the length of the piece.

Duties of the cut-lookers or piece taker-in.

All manufacturers know very well that it does not pay to produce cloth that can be turned "Seconds." At the same time one has to remember that weavers and looms are not yet absolutely perfect, so faults appear at times and cannot be prevented, but with reasonable care faults can be reduced to a minimum.

The piece taker-in in the weaving shed occupies one of the most important positions in a textile manufacturing concern, his duty being that of taking in and passing the pieces as they come from the weaving shed. So important is this work that it is impossible to give too much care to the selection of the person to fill the post. In no department of a factory are such breadth of vision and such all-round experience of textile processing required.

The piece taker-in-is indeed responsible for the class and quality of work being turned out. Since the best work is the requirement, any differences that exist between the work of one weaver and another must indicate deviations from that requirement, hence must be inefficiencies. Thus with the piece taker-in lies the responsibility of completing the education of the weavers.

To do this a large measure of tact is needed, a quality which to a great extent serves to distinguish a suitable from an unsuitable person occupying such a position. With tact little difficulty need be experienced in raising the quality of work coming from the looms; without it the task might as well not be attempted. Generally speaking weavers are as desirous of doing better work as are any other workers, if they are only shown how. Whatever momentary benefit may seem to result from skimped work, the work of the careful, conscientious weaver invariably proves more remunerative in the long run. It is for the piece examiner to build on this truth, and by his tactful counsel and advice to train into better ways those whose work calls for improvement. With discriminating judgment he can find endless means of pointing out how their methods may be altered and how various faults may be eliminated from their work. Considerable patience may be required in bringing about the desired change in weaver and work, but this is one of the ingredients in the nice perception and adroitness that go to form tact.

Tactfulness is necessary, too, in dealing with matters concerning which the overlookers are really responsible. Negligence on the part of overlookers may have disastrous results, which usually bring their own painful consequences. Lesser defaults, however, continually reveal themselve to the piece examiner through the work coming from the looms. Approached in the right spirit, any and all such faults, however trifling, may be and should be remedied. Continuous active co-operation between examiner, overlooker and weaver are the desideratum which tact and fitness for the task will accomplish.

It stands to reason that this educational work, however tactfully attempted, demands a backing of experience and ability if it is to be successful. The piece taker-in cannot be too well informed regarding textile materials and processes. Too little knowledge may quickly prove to be a dangerous thing. Intimate knowledge of weaving, for instance, is indispensable. This should, if possible, be substantiated by practical experience in weaving. If in other matters one ounce of experience is worth a ton of theory,

it is especially so in this work. How else can be examiner advise or help the weaver, much less the overlooker? His attempts in either direction, unless he is sure of his ground, and accurate in his findings and deductions, are liable to end in failure. Practical weaving experience qualifies him for dealing with the many problems presenting themselves in a manner that no amount of theory could do. This is a vital question if the greatest efficiency is desired, and is one calling for due consideration.

Beyond his knowledge of weaving, all-round experience of spinning and other operations is distinctly advantageous. Examination of pieces usually discloses as many spinning as weaving faults, and not infrequently the experience of the examiner is taxed to its uttermost in deciding as to the probable cause of a defect. Thorough ability in this is rare in a piece taker-in. It demands close, quick appreciation of the facts presented, and rapid deduction as to cause and effect. It operates in an almost intuitive marshalling of all possible causes and probable factors, an elimination of the unlikely and negligible, and a final logical summing up, leading directly to the cause or causes of the particulr fault. This qualification is rare, but is of priceless value in an examiner, as it may mean the detection and cure of faults which otherwise would pass through unchallenged, and ultimately prove a source of expense and loss.

Knowledge of dyeing and finishing processes is also of value, particularly as relating to the amount and the nature of mending that may require to be done to pieces. Without due thought being given to the after-treatment a piece will undergo, the time and money put into mending it may be largely if not entirely wasted. Whether to mend or not, and how to mend, are often questions the answer to which is governed very greatly by the processing which a piece will undergo in the dyeing and finishing stages. Another thing; many defects, as for instance barry and shady places, are often more or less invisible in the grey condition; these are a test of the ability of the examiner to decide on allowable limits to unevenness in yarns and in weaving. For this reason it is always well if a piece taken-in can have opportunity of seeing dyed and finished goods, particularly when any faults develop, as he has then a better chance of foreseeing recurrence of such troubles and will in consequence be in a better position to prevent them occurring at all.

In fact the position of a cut-looker is a very responsible one, because when the cloth passes his inspection it is assumed that it is marketable.

How is a Piece of Cloth Examined.

The cut-lookers examine the piecesm either on an power inspecting table or fold by fold, after it has been removed from the folding machine and laid on a flat table with a little slant towards the front side of the table. The piece is doubled over on itself once and each fold turned over by hand, and any defects noted. The other half is treated in a similar manner or on an inspecting slanting table the surface of which should be painted black. The cloth is drawn at the rate of 30/40 yards per minute.

It is very important to have every piece examined, in order to detect faults and trace them to the weaver who has caused them or allowed them to pass. It is also the means of detecting faults in the cloth that cannot be attributed to the weaver but to some other operative in the weaving department or in some other department, as for instance, wrong drafts in the drawing-in department, mixed weft or different counts, defective yarn produced in the spinning room, or local stains which should be divided into two classes—those which are fixed stains, as in the case of iron marks or moulds, and those which are likely to spread as in the case of graease spots.

Therefore it is the duty of the cut-lookers to report any fault to the person responsible, and put on one side the pieces in accordance to their standards :—whether "cuts or pieces" of cloth and be classed as "perfects", "seconds" or "rejects".

The seconds and rejects made during each working day should be recorded, and a daily list made out so that it can be inspected by the management, and steps taken to minimise the amount of defective cloth woven in the future.

Faults in Cloth.

Faulty cloth will be the result; (1) if the division in the warp is unnecessarily wide or over-shaded, then strain and breakages of the threads will be the result; (2) if the warp is not sufficiently divided or is undershaded, to allow the shuttle to pass through, therefore, the consequence is that it will be more over threads where it should move under or beneath them and a stronger pick is inevitable; (3) if one end of the shaft is lifted more than the other, then unequal shedding is caused; if the shafts by not being corded right lift or sink the warp to one level where the shuttle passes through it—that is, the shed should be as large as the shuttle at the point where it passes through, it must be quite clear of any obstruction. The line

of warp when the healds are levelled, should be below a line drawn from the temples to the back rest, and the lower the healds are in this respect the better is the cover on the cloth; (4) the healds should not be allowed to be low—that is, they should not rub against the race board, lest the warp will be frayed by the movement of the sley, and thus destroy the healds as well; (5) the treadles should neither be too forward or backward; (6) bare, badly covered cloth caused by the back rest of the loom being too low, the shed too large, late treading, and picking, too much weight, or too little weight or uneven shed; (7) mis-picks result when the loom, after having been stopped by the weft breaking or running out, has run for a pick or two before being entirely stopped, and then the weaver is starting with fresh weft has allowed the first pick of the new wefts to lie in the same shed as the last thus giving two consequtive picks in the same shed; (8) cracks are sometimes weaver's faults in not letting-back after weft breaking, taking up motion working unequally or through some parts not secured tightly; (9) broken picks result when a pick of the weft breaks partway across the shed, and is not removed so as to be replaced by a complete new pick; (10) ends-out are due to weavers failing to replace a broken end or ends as soon as breakage occurs; (11) uneven cloth is generally attributable to the unevenness of the weft, although may also be caused by unequal release of the warp from the beam, such as weights touching the floor, etc.; (12) smashes are produced by the shuttle remaining in the shed and breaking out a portion of the warp yarn. This can be remedied, if not of serious proportion, by the weaver piecing up the warp and making a new start in such a way as to avoid evidence of there having been a smash; (13) uneven cloth will be probable if the back rest or back bearer is too far from the healds, owing to the yarn between the healds and the back bearer having a jumping or bouncing movement as weaving is in progress, and when the loom is restarted, a crack will most likely appear; (14) floats are the result of obstruction in the shed, generally broken twist keeping down the warp threads and preventing their interweaving with the weft thus producing a hole in the cloth or a thin place which can generally be obliterated by means of weaver's comb; (15) the practice of leaving needle in the cloth should not be allowed; they should be looked for by the cut-looker and removed as well as broken teeth of combs, that have been used for scratching up defective places, any such metallic substances damage the calender bowls, if the cloth containing them is meant for calendering and this may damage the cloth for several yards; (16) broken patterns is the result of an end breaking in a figured cloth and is piced up to a wrong thread running together instead of one,

or a fine crack down the piece. A broken pattern may happen with any dobby or jacquard fabric, and occurs when the weaver does not adjust the tappet, lag of the dobby, or see the cards are correct with a Jacquard after repairing a broken end, or possibly the dobby or Jacquard machine is not working correctly; (17) wrong shade in colour yarn is a serious fault, and may result in goods being cancelled to the manufacturers (18) a dark patch will be seen across the piece if mixed weft is used.; (19) no blacklead marks should be allowed nor marks made by any materials containing wax or grease, if the cloth is meant for bleaching.

Oil stains are perhaps the greatest trouble in woven fabrics, since the cloth is liable to get oil on it from the weaving, spinning or finishing machinery. It is difficult at times to decide where the oil came from, especially when the cloth has been finished. If single threads are stained either in warp or weft, the spinner is responsible; when patches are seen in grey pieces, then the weaver is in the wrong.

Iron rust is another common stain in grey goods, but is easily detected. Often a series of stains appear right across the piece, caused by the reed of the loom becoming rusty through standing some time, so, when the yarn passes through, it gets Stained for a few inches. Rust stains sometimes appear passing through many laps of the cloth—this is caused by water dropping from a rusty pipe or from the water drain on the roof.

Appliances Required In The Folding Department.

The appliances required in the folding department are scissors, weaver's comb, cloth nippers, soap, water and ammonia.

The scissors are for the purpose of cutting out defective lengths of cloth, seperating the pieces of cloth into single cuts and clipping off loose ends of yarn. The comb consisting of a number of sharp teeth leaded into a brass back is for the purpose of scratching adjoining ends of warp or picks of wefts over a thin place or hole. The nippers are for the purpose of grasping lumps in the cloth that have not been otherwise removed by the weavers and drawing them out. Spots or streaks of black oil are common in cotton cloth and it can be removed by a solution of soap to which a little ammonia is added.

Grease spots, which are likely to spread and affect the adjacent folds, should always be taken out if they are at all bad, and cleaned with a dilute solution of either which can safely be used for cleaning delicate coloured goods.

In using these agents, a pad of white blotting paper, or some absorbent textile material should be placed underneath the stain

and its position constantly changed as the cleaning process goes on. The cleansing agent is then gently rubbed down from the cloth into the pad below. It is best to work from the outside of the stain inward, during the early part of the operations, and special care should be taken to prevent an outer ring being left around the spot where the stain has been, any lump of grease should be drawn out with a cloth nippers before any cleaning agent is resorted to.

Oil Stains.—Mineral oil stains should be removed as soon as possible by treating them with benzoine.

Iron Stains—May be removed by treating with dilute hydrochloric acid. If the stains be very persistent and resist this treatment, strong hydrochloric acid should be used and the part affected rubbed with a crystal of sulphate of copper, and then the cloth should be well washed.

All Tar Stains—May be removed by treating them with turpentine or grease, and then washing the part with soap and water.

The cut-looker, when examining grey cloth from the looms, should test the pieces for weight, and if any pieces come under the average for that particular cloth, then he ought to find out the reason for the light weight—the ends or picks per inch may be less than required, the yarns may be of a finer count, or possibly the cloth has less size than usual. The width and length should also be examined.

Bleached Goods—When examining bleached cloth received from the bleaching department, the finish, colour and strength should be considered. The most reliable test for colour is by comparing the goods with some white samples. The defects of colour are either yellowish or inclined to being blue. Cloth that is yellow can be made to look white by the use of blue, but nearly all the blue colours used are soluble in water, so if there is doubt about the bleach, wash a sample well in cold water, and after drying, if it looks yellow, it has been blued. Bleaching cotton threads makes them stronger than when grey, so by testing the threads of the bleached cloth a thread tester you can ascertain if the cloth has been tendered or not, by comparison with the grey tests.

White cotton goods have a tendency to become yellowish. Coloured goods alter through atmospheric changes and the foreign bodies present in air, especially dust, smoke, etc. If cotton cloth is stored in places where air cannot circulate freely, there is a liability for mildew to attack it, especially in damp rooms.

The perfect pieces when sorted out by the cut-looker, are arranged and sent out to their respective departments. For instance if the cloths are meant for calendering they are sent to be calendered, if for finishing, then they are sent out to be finished, or if for bleaching they are sent out to be bleached after the cloth receives any of the above three treatments though they are sometimes also sold in the grey state (that is, neither calendered, bleached or finished). They are folded and doubled each over itself as required by the buyer, and then stamped on the outside of it. The pieces after being stamped are bundled up 5 or 10 pieces in a bundle in a small bundling press, then baled up in a hydraulic press and sent to the market to the various merchants through a commission agent.

Stenter or Stretching Machine.

This machine is particularly useful to straighten the wet and selvedges of the cloth which may have become distorted during the bleaching and other processes. This mechanism is situated at the delivery end on the vertical shaft which drives one of the clip chains. It enables one of the clip chains to run faster or slower than the other chain for the period necessary to straighten the weft. The speed variation is obtained through differential gearing from the driving shaft, and is operated by means of brake pulleys.

The cloth enters over stave rails, and is gripped by two endless chains of automatic clips. The rails are adjustable in width by screws and hand wheels.

Under the first section of rails a perforated steam pipe is often placed to damp the cloth, and thus facilitate Stretching. A battery of steam-heated gilled pipes is placed under the last section of rails to dry out the moisture before the cloth leaves the clips.

High-speed Stentering Range.

The stenter stretches and dries the cloth, straightens the weft threads, and when combined with a starch Mangle is used to add weight and softness to the fabric. During the bleaching operation the cloth has Shrunk often to a considerable degree, but almost the original width can be regained on the Stentering Machine. Many high-class modern finishes are obtained on a Starching and Stentering Machine without any subsequent finishing process. The hot air

not only dries the cloth, but in many cases restores the natural appearance of the weave and gives a springy feel to the fabric which cannot be obtained on steam-heated drying cylinders stenter clips.

The stenter clip is one of the most important parts of a stenter frame. Unless the clip is well designed and suitable for the type of fabric for which it is required, no Stentering Machine, however efficient in other respects, will give satisfactory results.

Bundling the Cloth.

There are two kinds of bundling press namely geared press and hydraulic press. Both types are made in various sizes, representative geared presses having tables 50 or 60 inches long and 20 inches wide, with an opening of 24 or 30 inches in height. In most of the geared presses the bottom table rises about 9 inches and is lifted by means of cam motion worked by very powerful gearing. The machines are also provided with a stop motion to stop the machines at any required point, so as to ensure as far as possible all bundles being the same size.

The main features of the hydraulic press for cloth, are similar to those of geared press, the only difference being in the method of raising the table to compress the cloth. On the shaft on which the belt pulleys are mounted are keyed two eccentric sheaves that drive the connecting-rods. The lower ends of these rods are connected to the rods of two small force pumps working in a tank.

A small delivery pipe from these pumps leads to the cylinder in which works a ram that is attached to the table. The tank is filled with oil, and when this is forced by the pumps into the cylinder it causes the ram to rise, carrying with it the table and compressing the bundles of cloth. The belt fork is attached to a rod that terminates in a handle on the other side of the press, and a spiral spring attached to the rod tends to pull the driving belt on to the loose pulley. In starting the press the starting handle is pulled over, against the pull of the spring, until the belt is on the fast pulley, and at this point a latch drops into a slot in the fork rod and holds it. The pressure applied by the pumps is maintained even after the pumps are stopped, until released by opening the tap which allows the oil to flow back again into the tank, the weight of the table and the bundle forcing the ram back into the cylinder until the press becomes stationary with the table at the lowest point, ready for the

next bundles. A lever safety valve fitted with a weight is provided for relieving the pressure if from any cause the machine does not stop in time to prevent damage to pipes, tank, or cylinder. In some hydraulic presses there is no knocking-off motion to stop the press when the table reaches a certain height; instead, the presser moves the belt on to the loose pulley when he considers that the bundles are pressed sufficiently. If the belt is not moved soon enough, or if the safety valve is too heavily loaded, then either some part of the press will be broken or the belt will slip off the pulley. In starting up the press after the bundles to be pressed have been put on the table, the tap must be closed to enable the pumps to force oil into the cylinder again; the tap must then be left closed until it has to be opened to remove the press. Although oil is preferable, water is generally used in India in the cylinders of hydraulic presses. With this there is always the risk of corrosion, and the ram should therefore be well rubbed with tallow, at intervals, when it is at the top of its stroke.

Driving.

Finishing department should be equipped with 2-75 B. H. P. motors for 7-Bowl calenders, 1–55 B. H. P. motor for 3–Bowl friction calender, 1–25 B.H.P. for driving 1 Baling press, 7 folding machines, 1 bundling machine and 1 stamping machine.

Baling Press.

Power	= 6 I.H.P.
Pressure capacity	= $1\frac{1}{2}$ to 2 tons.
Speed	=200 R.P.M.
Production	= one press is enough for 500 to 100° looms

Stamping Ink.

Red I.

5 Parts .... Eosine S. Extra yellowish.
20 .. .. Hot Water.
5 „ .... Glycerine.
70 „ .... Gelatine 1 : 7 Solution.

100

Red II.

5 Parts .... Eosine B. Extra.
20 „ .... Hot Water.
3 „ .... Glycerine.
72 „ .... Gelatine 1 : 7 Solution.

100

Red III

5 Parts .... Brilliant Poncean By 7.
20 „ .... Hot Water.
3 „ .... Glycerine.
72 „ .... Gelatine 1 : 5 Solution.

100

Red IV.

3 lbs. .... Eosine Red G.G.F.
2 „ .... Farina.
2 „ .... Gum Arabic.
2½ Galls. .... Cold Water.
Few Drops .... Carbolic oil to be added after mixing first in hot water.

Boil to paste and when cool add Few drops of Liq. Ammonia or Vinegar.

Blue I.

0.5 Parts .... Navy Blue R.N.
20 , ... Hot Water.
5 „ .... Zinc White.
3 „ .... Glycerine.
72 „ .... Gelatine 1 : 7.

100

Blue II.

3 Parts	....	Brilliant Milling Blue B.
20 ,,	....	Hot Water.
5 ,,	....	Zinc White.
3 ,,	....	Glycerine.
69 ,,	....	Gelatine 1 : 7.
100		

Blue III.

3 Parts	....	Export Blue B.S.E.G.
20 ,,	....	Hot Water.
5 ,,	....	Zinc White.
3 ,,	....	Glycerine.
69 ,,	....	Gelatine 1 : 7. Solution.
100		

Blue IV.

3 Parts	....	Water Blue B. Powder.
25 ,,	....	Hot Water.
3 ,,	....	Glycerine.
5 ,,	....	Zinc White.
64 ,,	....	Gelatine 1 : 7 Solution.
100		

Blue V.

3 Parts	....	Pure Solution Blue Crystals.
20 ,,	....	Hot Water.
5 ,,	....	Zinc White.
3 ,,	....	Glycerine.
69 ,,	....	Gelatine 1 : 7 Solution.
100		

Navy Blue VI.

0.5 Parts	....	Navy Blue R.N.
20 ,,	....	Zinc White.
24.5 ,,	....	Hot Water.
3 ,	....	Glycerine.
52 ,,	....	Gelatine 1 : 5 Solution.
100		

Navy Blue VII.

3	Parts	Navy Blue R.N.
20	,, ...	Hot Water.
3	,, ...	Glycerine.
74	,, ...	Gelatine 1 : 7 Solution.
100		

Blue VIII.

4 ozs.	....	Methyline Blue.
2 lbs.	....	Farina (mixed in 1 gall. of cold water)
1 lb.	....	Gum Arabic. (dissolved in ½ Gall. hot water) add few drops of carbolic oil mixed in hot water before boiling....

Boil to a paste.

Blue IX.

3 ozs.	....	Oxamine Blue B.B. (Redish).
3 lbs.	....	Oxide of Zinc.
8 ,,	....	Gum Arabic.
16 ,,	....	Water.

Dissolve gum in hot water, strain it, Boil for 20 minutes, add oxide of zinc, and then colour.

White Stamping Ink I.

2 lbs.	....	Whiting.
2 ozs.	....	Cocoanut oil.
1 lb.	....	Gum Arabic (dissolved in ¼ Gall. water)
4 ozs.	....	Terpentine.

Mix 1 and 2 to form paste add 3 and 4.

Stir well while adding the ingredients.

White II.

2 lbs.	....	French Chalk.
1 ,,	....	Mineral White.
1 oz.	....	Cocoanut oil.
1 lb.	....	Gum Arabic (dissolved in ¼ Gal. hot water).
4 ozs.	....	Terpentine.

Mix 1, 2, and 3 to form paste in small quantity of water, add 4 and 5.

Stir well while mixing up the ingredients.

Mode of Preparation.

Red Nos. I. II and III. and Blue Nos. I to VII.

(1) Mix colour in Hot water.
(2) Prepare gelatine Solution.
(3) Mix 1 and 2.
(4) Add Zinc White and Glycerine.

Stenciling Ink.

8 lbs.	....	Gall Nuts.
3 ,,	....	Sulphate of Iron.
4 ,,	....	Ultramarine Blue or Waste water of Sulphur Black.

Crush the Skin of gall nuts (extract the seeds out and throw them away)

Mix in 3 gallons of hot water.
Add Sulphate of iron.
Let it Stand 8 to 12 hours.

Add Blue or waste water of Sulphur black and then it will be ready for use.

Stamping Tar For Cloth For Bleaching.

Equal parts of ordinary coal Tar and Lamp Black mixed together and used.

"Indelible Ink for marking on cloth for Bleaching" etc.

85 parts	....	Aniline oil.
5 ,,	....	Potassium chlorate.
44 ,,	....	Distilled Water.
68 ,,	....	Hydrochloric acid pure (S. gravity 1.124)
6 ,,	....	Copper chloride pure.

Mix the aniline oil, potassium chlorate, and 26 parts of the water and heat in a capacious vessel, on the water bath, at a temperature of from 175° to 195° Fah. until the chlorate is entirely dissolved, then add one half of the hydrochloric and continue the heat until the mixture begins to take on a darker colour. Dissolve the copper chloride in the residue of the water, add the remaining hydrochloric acid to the solution, and add the whole to the liquid on the water bath, and heat the mixture until it acquires a fine red-violet colour. Pour into a flask with a well-fitting ground-glass stopper close tightly and set aside for several days or until it ceases to throw down a precipitate. When this is the case, pour off the clear liquid into smaller (one drachm or a drachm and a half) containers. This ink must be used with a quill pen and is especially good for linen or cotton fabrics.

Fireproof Mixture.

I,	Ammonium Sulphide	8	Parts.
	Ammonium Carbonate	2½	,,
	Boric Acid	3	,,
	Soduim Borate	1¾	,,
	Water	200	gallons.

II.	Phospate of Ammonia	1 lb.
	Sal Ammonisc	2 lbs,
	Water	1 gallon.

CHAPTER XLIX.

WATER QUANTITIES.

1 pint	= 34.65 cubic inches		=	$1\frac{1}{4}$ lb.
1 quart	= 69.31	,,	=	$2\frac{1}{2}$ lb.
1 gallon	=277.25	,,	=	10 lb.
1 cubic inch	—	,,	=	.0361 lb.
1 cubic foot	= 1728	,,	=	62.5 lb.
1 cubic foot	= 6.25 gallons		=	
1 cylindrical foot	= 4.893	,,	=	
1 cubic yard	=168.264	,,		
1 ton of water	= 35.76 cubic feet		=	224 gallons

1 gallon of water would fill a box $6'' \times 6'' \times 7\frac{3}{4}''$

1 quart of water would fill a box $4'' \times 4'' \times 4\frac{1}{3}''$

A cylinder containing a gallon for every inch of its depth would be 18.78933 inches in diameter.

Water occupies the least space at 4°C. or 39°F.

SPECIFIC GRAVITY OF SOLUTIONS OF CHLORIDE OF LIME.

At 95° F.

Specific Gravity	Grams effective chlorine per litre	Specific Gravity	Grams effective chlorine per litre
1.0018	1.0	1.039	23.0
1.0025	1.40	1.04	23.75
1.0036	2.0	1.0407	24.0
1.005	2.71	1.042	25.0
1.0054	3.0	1.044	26.0
1.007	4.0	1.045	26.62
1.009	5.0	1.046	27.0
1.01	5.88	1.0474	28.0
1.0108	6.0	1.049	29.0
1.0126	7.0	1.05	29.60
1.014	8.0	1.0506	30.0
1.015	8.48	1.0539	32.0
1.016	9.0	1.055	32.68
1.0177	10.0	1.057	34.0
1.0194	11.0	1.06	35.81
1.02	11.41	1.0603	36.0
1.0215	12.0	1.0633	38.0
1.0226	13.0	1.065	39.10
1.024	14.0	1.0664	40.0
1.025	14.47	1.0695	42.0
1.0258	15.0	1.07	42.31
1.0275	16.0	1.0726	44.0
1.029	17.0	1.075	45.70
1.03	17.36	1.0756	46.0
1.031	18.0	1.0786	48.0
1.0325	19.0	1.08	48.9
1.034	20.0	1.0817	50.0
1.035	20.44	1.0848	52.0
1.0357	21.0	1.085	52.27
1.0374	22.0	1.09	55.18

CONVERSION

of grammes (colour) per 100 kilos goods into ozs. (colour) per 100 lbs. goods.

grms.	ozs.	grms.	ozs.	grms.	ozs.	grms.	ozs.
7¾	⅛	257¾	4⅛	507¾	8⅛	757¾	12⅛
15½	¼	265½	4¼	515½	8¼	765½	12¼
23¼	⅜	273¼	4⅜	523¼	8⅜	773¼	12⅜
31	½	281	4½	531	8½	781	12½
38¾	⅝	288¾	4⅝	538¾	8⅝	788¾	12⅝
46½	¾	296½	4¾	546½	8¾	796½	12¾
54¼	⅞	304¼	4⅞	554¼	8⅞	804¼	12⅞
62	1	312	5	562	9	812	13
62½		312½		562½		812½	
70¼	1⅛	320¼	5⅛	570¼	9⅛	820¼	13⅛
78	1¼	328	5¼	578	9¼	828	13¼
85¾	1⅜	335¾	5⅜	585¾	9⅜	835¾	13⅜
93½	1½	343½	5½	593½	9½	843½	13½
101¼	1⅝	351¼	5⅝	601¼	9⅝	851¼	13⅝
109	1¾	359	5¾	609	9¾	859	13¾
116¾	1⅞	366¾	5⅞	616¾	9⅞	866¾	13⅞
124½	2	374½	6	624½	10	874½	14
125		375		625		875	
132¾	2⅛	282¾	6⅛	632¾	10⅛	882¾	14⅛
140½	2¼	390½	6¼	640½	10¼	890½	14¼
148¼	2⅜	398½	6⅜	648¼	10⅜	898¼	14⅜
156	2½	406	6½	656	10½	906	14½
163¾	2⅝	413¾	6⅝	663¾	10⅝	913¾	14⅝
171½	2¾	421½	6¾	671½	10¾	921½	14¾
179¼	2⅞	429¼	6⅞	679¼	10⅞	929¼	14⅞
187	3	437	7	687	11	937	15
195¼		437½		687½		937½	
203	3⅛	445¼	7⅛	695¼	11⅛	945¼	15⅛
210¾	3¼	453	7¼	703	11¼	953	15¼
218½	3⅜	460¾	7⅜	710¾	11⅜	960¾	15⅜
226¼	3½	468½	7½	718½	11½	968½	15½
234	3⅝	476¼	7⅝	726¼	11⅝	967¼	15⅝
241¾	3¾	484	7¾	734	11¾	984	15¾
249½	3⅞	491¾	7⅞	741¾	11⅞	991¾	15⅞
250	4	499½	8	749½	12	999½	1 lb.
		500		750		1000	

CONVERSION OF PERCENTAGES INTO ENGLISH WEIGHTS.

%	For 1 lb.		For 5 lb.		For 10 lb.		For 25 lb.		For 50 lb.		For 100 lb.	
10.0%	1 oz.	263 gr	8 oz.	0 gr.	16 oz.	0 gr.	2 lb.	8 oz.	5 lb.	0 oz.	10 lb.	
9.0%	1	193	7	88	14	175	2	4	4	8	9	
8.0%	1	123	6	175	12	350	2	0	4	0	8	
7.0%	1	53	5	263	11	87	1	12	3	8	7	
6.0%		420 gr.	4	350	9	263	1	8	3	0	6	
5.0%		350	4	0	8	0	1	4	2	8	5	
4.0%		280	3	88	6	175	1	0	2	0	4	
3.0%		210	2	175	4	350	12 oz.	0 gr.	1	8	3	
2.0%		140	1	263	3	88	8	0	1	0	2	
1.0%		70		350 gr	1	263	4	0	8 oz.	0 gr.	1	
0.9%		63		315	1	193	3	263	7	88	14 oz.	175 gr.
0.8%		56		280	1	123	3	88	6	175	12	350
0.75%		52		262	1	88	3	0	6	0	12	0
0.7%		49		245	1	53	2	350	5	263	11	88
0.6%		42		210		420 gr.	2	175	4	350	9	263
0.5%		35		175		350	2	0	4	0	8	0
0.4%		28		140		280	1	263	3	88	6	175
0.3%		21		105		210	1	88	2	175	4	350
0.25%		18		87		175	1	0	2	0	4	0
0.2%		14		70		140		350gr.	1	263	3	88
0.1%		7		35		70		175		350 gr.	1	263
0.09%		6		30		63		152		315	1	193

%	For 1 lb.	For 5 lb.	For 10 lb.	For 25 lb,	For 50 lb.	For 100 lb.
0.08%	—	27	56	140	280	1 123
0.075	5	25	53	126	252	1 88
0.07%	—	22	49	112	245	1 53
0.06%	4	20	42	105	210	420 gr.
0.05%	3	15	35	88	175	350
0.04%	—	12	28	70	140	280
0.03%	2	10	21	53	105	210
0.025%	—	7	18	44	88	175
0.02%	1	5	14	35	70	140
0.01%	—	3	7	17	35	70
0.009%	—	—	6	16	31	63
0.008%	—	—	—	14	28	56
0.007%	—	—	5	12	24	49
0.006%	—	—	4	10	21	42
0.005%	—	—	—	8	17	35
0.004%	—	—	3	7	14	28
0.003%	—	—	2	5	10	21
0.002%	—	—	1	3	7	14
0.001%	—	—	—	1	3	7

EXAMPLE : To covert 0.08% on 35 lb. into English weight :

0.08% or 25 lb. = 140 gr.
0.08% or 10 lb. = 56 gr.
0.08% or 10 lb. = 56 gr.

There are 0.08% or 35 lb. = 196 gr.

COMPARATIVE TEMPERATURES CENTIGRADE AND FAHRENHEIT.

Tempt. Cent. $=\frac{5}{9}$ (temp. fahr. -32)

Temp Fahr. $=32 \times \frac{9}{5}$ (temp. cent.)

Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
—5	23.0	31	87.8	67	152.6
—4	24.8	32	89.6	68	154.4
—3	26.6	33	91.4	69	156.2
—2	28.4	34	93.2	70	158.0
—1	30.2	35	95.0	71	159.8
0	32.0	36	96.8	72	161.6
+1	33.8	37	98.6	73	163.4
2	35.6	38	100.4	74	165.2
3	37.4	39	102.2	75	167.0
4	39.2	40	104.0	76	168.8
5	41.0	41	105.8	77	170.6
6	42.8	42	107.6	78	172.4
7	44.6	43	109.4	79	174.2
8	46.4	44	111.2	80	176.0
9	48.2	45	113.0	81	177.8
10	50.0	46	114.8	82	179.6
11	51.8	47	116.6	83	181.4
12	53.6	48	118.4	84	183.0
13	55.4	49	120.2	85	185.0
14	57.2	50	122.0	86	186.8
15	59.0	51	123.8	87	188.6
16	60.8	52	125.6	88	190.4
17	62.6	53	127.4	89	192.2
18	64.4	54	129.2	90	194.0
19	66.2	55	131.0	91	195.8
20	68.0	56	132.8	92	197.6
21	69.8	57	134.6	93	199.4
22	71.6	58	136.4	94	201.2
23	73.2	59	138.2	95	203.0
24	75.4	60	140.0	96	204.8
25	77.0	61	141.8	67	206.6
26	78.8	62	143.6	98	208.4
27	80.6	63	145.4	99	210.2
28	82.4	64	147.2	100	212
29	84.2	65	149.0	101	218.8
30	86.0	66	150.8	102	215.6

COMPARATIVE HYDROMETER SCALES.

Baumé, Twaddell, and Specific Gravity at 60°F.(15°C.)

Baumé	Twddell	Specific Gravity	Baumé	Twaddell	Specific Gravity.
0	0	1.000	34	61.6	1.308
1	1.4	1.007	35	64.0	1.320
2	2.8	1.014	36	66.4	1.332
3	4.4	1.022	37	69.0	1.345
4	5.8	1.029	38	71.4	1.357
5	7.4	1.037	39	74.0	1.370
6	9.0	1.045	40	76.6	1.383
7	10.2	1.052	41	79.4	1.397
8	12.0	1.060	42	82.0	1.410
9	13.4	1.067	43	84.8	1.424
10	15.0	1.075	44	87.0	1.438
11	16.6	1.083	45	90.6	1.453
12	18.2	1.091	46	93.6	1.468
13	20.0	1.100	47	96.6	1.483
14	21.6	1.108	48	99.6	1.498
15	23.2	1.116	49	103.0	1.514
16	25.0	1.125	50	106.0	1.530
17	26.8	1.134	51	109.2	1.540
18	28.4	1.142	52	112.6	1.563
19	30.4	1.152	53	116.0	1.580
20	32.4	1.162	54	119.4	1.597
21	34.2	1.171	55	123.0	1.615
22	36.0	1.180	56	127.0	1.634
23	38.0	1.190	57	130.0	1.652
24	40.0	1.200	58	134.0	1.672
25	42.0	1.210	59	138.2	1.691
26	44.0	1.220	60	142.0	1.711
27	46.2	1.231	61	146.4	1.732
28	48.2	1.241	62	150.0	1.753
29	50.4	1.252	63	155.0	1.774
30	52.6	1.263	64	159.0	1.796
31	54.8	1.274	65	164.0	1.819
32	57.0	1.285	66	168.4	1.840
33	59.4	1.297			

SPECIFIC GRAVITY AND DEGREES Tw.

Spec. Grav. (at 15°)	Degrees Twaddell	Spec. Grav. (at 15°)	Degrees Twaddell	Spec. Grav. [at 15°]	Degrees Twaddell	Spec. Grav. [at 15°]	Degrees Twaddell
1,000	0	1,215	43	1,430	86	1,645	129
1,005	1	1,220	44	1,435	87	1,650	130
1,010	2	1,225	45	1,440	88	1,655	131
1,015	3	1,230	46	1,445	89	1,660	132
1,020	4	1,235	47	1,450	90	1,665	133
1,025	5	1,240	48	1,455	91	1,670	134
1,030	6	1,245	49	1,460	92	1,675	135
1,035	7	1,250	50	1,465	93	1,680	136
1,040	8	1,255	51	1,470	94	1,685	137
1,045	9	1,260	52	1,475	95	1,690	138
1,050	10	1,265	53	1,480	96	1,695	139
1,055	11	1,270	54	1,485	97	1,700	140
1,060	12	1,275	55	1,490	98	1,705	141
1,065	13	1,280	56	1,495	99	1,710	142
1,070	14	1,285	57	1,500	100	1,715	143
1,075	15	1,290	58	1,505	101	1,720	144
1,080	16	1,295	59	1,510	102	1,725	145
1,085	17	1,300	60	1,515	103	1,730	146
1,090	18	1,305	61	1,520	104	1,735	147
1,095	19	1,310	62	1,525	105	1,740	148
1,100	20	1,315	63	1,530	106	1,745	149
1,105	21	1,320	64	1,535	107	1,750	150
1,110	22	1,325	65	1,540	108	1,755	151
1,115	23	1,330	66	1,545	109	1,760	152
1,120	24	1,335	67	1,550	110	1,765	153
1,125	25	1,340	68	1,555	111	1,770	154
1,130	26	1,345	69	1,560	112	1,775	155
1,135	27	1,350	70	1,565	133	1,780	156
1,140	28	1,355	71	1,570	114	1,785	157
1,145	29	1,360	72	1,575	115	1,790	158
1,150	30	1,365	73	1,580	116	1,795	159
1,155	31	1,370	74	1,585	117	1,800	160
1,160	32	1,375	75	1,590	118	1,805	161
1,165	33	1,380	76	1,595	119	1,810	162
1,170	34	1,385	77	1,600	120	1,815	163
1,175	35	1,390	78	1,605	121	1,820	164
1,180	36	1,395	79	1,610	122	1,825	165
1,185	37	1,400	80	1,615	123	1,830	166
1,190	38	1,405	81	1,620	124	1,835	167
1,195	39	1,410	82	1,625	125	1,840	168
1,200	40	1,415	83	1,630	126	1,845	169
1,205	41	1,420	84	1,635	127	1,850	170
1,210	42	1,425	85	1,640	128	1,855	171

To convert—	*Multiply by*
Feet into miles	0.00019
Miles into feet	5280
Yards into miles	0.00057
Miles into yards	1760
Inches into metres	0.0254
Metres into inches	39.37
Inches into centimetres	2.54
Centimetres into inches	0.3937
Feet into metres	0.3048
Metres into feet	3.2809
Yards into metres	0.9144
Metres into yards	1.0936
Miles into kilometres	1.6093
Kilometres into miles	0.6214
Square inches into square feet	0.00694
Square feet into square inches	144
Square inches into square centimetres	6.4516
Square centimetres into square inches	0.155
Square feet into square metres	0.0929
Square metres into square feet	10.764
Square yards into square metres	0.8361
Square metres into square yards	1.196
Cubic inches into cubic feet	0.00058
Cubic feet into cubic inches	1728
Cubic inches into cubic centimetres	16.387
Cubic centimetres into cubic inches	0.06092
Cubic feet into gallons	6.235
Gallons into cubic eet	0.16037
Cubic inches into gallons	0.0036
Gallons into cubic inches	277
Cubic feet into litres	28.33
Litres into cubic feet	0.0353
Litres into cubic feet	0.0353
Cubic centimetres into pints	0.00176
Pints into cubic centimetres	567.936
Gallons into litres	4.5435
Litres into gallons	0.2205
Grains into ounces	0.00228
Ounces into grains	437.5
Grains into grammes	0.0648
Grammes into grains	15.4324
Ounces into grammes	28.3495
Grammes into ounces	0.0353
Pounds into kilogrammes	0.45359
Kilogrammes into pounds	2.2046

Conversion of Gallons into Litres

Imperial gallons		litres.
1	=	4.5484
2	=	9.0872
3	=	13.6308
4	=	18.1748
5	=	22.718
6	=	27.2616
7	=	31.8052
8	=	36.3488
9	=	40.8924
10	=	45.436
20	=	90.872
30	=	136.308
40	=	181.744
50	=	227.180
60	=	272.616
70	=	318.051
80	=	363.488
90	=	408.925
100	=	454.360
200	=	908.720
300	=	1,363.080
400	=	1,817.440
500	=	2,271.800
1,000	=	4,543.600

Conversion of Litres Gallons and Pints

litres		gall.	pt.
1	=	0	1¾
2	=	0	3½
3	=	0	5¼
4	=	0	7
5	=	1	0¾
6	=	1	2½
7	=	1	4¼
8	=	1	6
9	=	1	7¾
10	=	2	1½
11	=	2	3¾
12	=	2	5
13	=	2	6¾
14	=	3	0½
15	=	3	2¼
16	=	3	4
17	=	3	5¾
18	=	3	7½
19	=	4	1¼
20	=	4	3¾
21	=	4	5
22	=	4	6¾
23	=	5	0½
24	=	5	2¼
25	=	5	4
50	=	11	0½
75	=	16	4½
100	=	22	0¾

Conversion of "Grams per Litre" to "Ounces per Gallon."

Per litre. Grams.		Per Gallon. Ozs.	Per Gallon. Grains.
100	=	16	0
90	=	14	175
80	=	12	350
75	=	12	0
70	=	11	87
60	=	9	262
50	=	8	0
40	=	6	175
30	=	4	350
25	=	4	0
20	=	3	87
10	=	1	262
9	=	1	193
8	=	1	127
7	=	1	57
6	=	..	423
5	=	..	354
4	=	..	280
3	=	..	210
2	=	..	140
1	=	..	70
0.75	=	..	53
0.5	=	..	35
0.25	=	..	17

Conversion of Ounces into Kilogrammes.

1 oz.	=	437½	grains	=	28.34	grammes.
2 oz.	=	875	,,	=	56.70	,,
3 oz.	=	1312	,,	=	85.04	,,
4 oz.	=	1750	,,	=	113.39	,,
5 oz.	=	2187½	,,	=	141.74	,,
6 oz.	=	2625	,,	=	170.09	,,
7 oz.	=	3062½	,,	=	198.44	,,
8 oz.	=	3500	,,	=	226.79	,,
9 oz.	=	3937½	,,	=	255.14	,,
10 oz.	=	4375	,,	=	283.49	,,
11 oz.	=	4812½	,,	=	311.84	,,
12 oz	=	5250	,,	=	340.19	,,
13 oz.	=	5687½	,,	=	368.54	,,
14 oz.	=	6125	,,	=	396.89	,,
15 oz.	=	6562½	,,	=	425.24	,,
16 oz.	=	7000	,,	=	453.59	,,
1 milligramme				=	0.001	grammes.
1 centigramme				=	0.01	,,
1 decigramme				=	0.1	,,
1 decagramme				=	10.000	,,
1 hectogramme				=	100.000	,,
1 kilogramme				=	1000.000	,,

Conversion of English Pounds into Kilogrammes.

1	lb. English	=	0.453	kilos	30	lb. English	=	13.594	kilo
2	,, ,,	=	0.906	,,	31	,, ,,	=	14.047	,,
3	,, ,,	=	1.359	,,	32	,, ,,	=	14.500	,,
4	,, ,,	=	1.812	,,	33	,, ,,	=	14.953	,,
5	,, ,,	=	2.265	,,	34	,, ,,	=	15.406	,,
6	,, ,,	=	2.719	,,	35	,, ,,	=	15.859	,,
7	,, ,,	=	3.172	,,	36	,, ,,	=	16.312	,,
8	,, ,,	=	3.625	,,	37	,, ,,	=	16.765	,,
9	,, ,,	=	4.078	,,	38	,, ,,	=	17.218	,,
10	,, ,,	=	4.531	,,	39	,, ,,	=	17.671	,,
11	,, ,,	=	4.984	,,	40	,, ,,	=	18.125	,,
12	,, ,,	=	5.437	,,	41	,, ,,	=	18.578	,,
13	,, ,,	=	5.890	,,	42	,, ,,	=	19.031	,,
14	,, ,,	=	6.343	,,	43	,, ,,	=	19.484	,,
15	,, ,,	=	6.796	,,	44	,, ,,	=	19.937	,,
16	,, ,,	=	7.249	,,	45	,, ,,	=	20.390	,,
17	,, ,,	=	7.702	,,	46	,, ,,	=	20.843	,,
18	,, ,,	=	8.155	,,	47	,, ,,	=	21.296	,,
19	,, ,,	=	8.608	,,	48	,, ,,	=	21.749	,,
20	,, ,,	=	9.062	,,	49	,, ,,	=	22.202	,,
21	,, ,,	=	9.515	,,	50	,, ,,	=	22.656	,,
22	,, ,,	=	9.968	,,	60	,, ,,	=	27.187	,,
23	,, ,,	=	10.421	,,	70	,, ,,	=	31.719	,,
24	,, ,,	=	10.874	,,	80	,, ,,	=	36.250	,,
25	,, ,,	=	11.327	,,	90	,, ,,	=	40.781	,,
26	,, ,,	=	11.780	,,	100	,, ,,	=	45.302	,,
27	,, ,,	=	12.233	,,	200	,, ,,	=	90.625	,,
28	,, ,,	=	12.686	,,	300	,, ,,	=	135.937	,,
29	,, ,,	=	13.139	,,	400	,, ,,	=	181.250	,,
					500	,, ,,	=	226.562	,,

Conversion of Kilograms into English Pounds.

Kilos.		cwts.	qrs.	lbs.	ozs.	Approximate conversion into lbs.
1	=	0	0	2	3¼	2⅛
2	=	0	0	4	6½	4⅜
3	=	0	0	6	9¾	6⅝
4	=	0	0	8	13	8⅞
5	=	0	0	11	0¼	11
6	=	0	0	13	3½	13⅕
7	=	0	0	15	7	15½
8	=	0	0	17	10¼	17⅝
9	=	0	0	19	13½	19⅞
10	=	0	0	22	0¾	22⅛
20	=	0	1	16	1½	44¼
30	=	0	2	10	2½	66⅜
40	=	0	3	4	3	88
50	=	0	3	26	3¾	110¼
60	=	1	0	20	4½	132
70	=	1	1	14	5¼	154
80	=	1	2	8	6	176
90	=	1	3	2	6½	198
100	=	1	3	24	7	220½
200	=	3	3	20	15	441
300	=	5	3	17	6	661½
400	=	7	3	13	14	882
500	=	9	3	10	5	1,102½

1 Kilo = 2.2046 lbs.
1 gramme = 15.43235 grains.
10 grammes = 154.32356 grains.
100 grammes = 3 ozs. 231 grains.
500 grammes = 1 lb. 1 oz. 280 grains.
1000 grammes = 2 lbs. 3 ozs. 120 grains.
1 center = 50 kilos = 110¼ lbs.

Conversion of Grammes into Ounces and Grains.

grammes	grains	oz.	grains	grammes	grains	oz.	grains
28.35	= 437.50 =	1					
29	= 447.53 =	1	10	65	=1003.10 =	2	128
30	= 462.97 =	1	25	66	=1018.53 =	2	144
31	= 478.40 =	1	41	67	=1033.96 =	2	159
32	= 493.83 =	1	56	68	=1049.39 =	2	174
33	= 509.26 =	1	72	69	=1064.83 =	2	190
34	= 524.69 =	1	87	70	=1080.26 =	2	205
35	= 540.13 =	1	102	71	=1095.69 =	2	220
36	= 555.56 =	1	118	72	=1111.12 =	2	236
37	= 570.99 =	1	133	73	=1126.56 =	2	252
38	= 586.42 =	1	149	74	=1141.99 =	2	267
39	= 601.86 =	1	164	75	=1157.42 =	2	282
40	= 617.29 =	1	180	76	=1172.85 =	2	298
41	= 632.72 =	1	195	77	=1188.29 =	2	313
42	= 648.15 =	1	210	78	=1203.72 =	2	329
43	= 663.59 =	1	226	79	=1219.15 =	2	344
44	= 679.02 =	1	241	80	=1234.58 =	2	360
45	= 694.45 =	1	257	81	=1250.02 =	2	375
46	= 709.88 =	1	272	82	=1265.45 =	2	390
47	= 725.32 =	1	288	83	=1280.88 =	2	406
48	= 740.75 =	1	303	84	=1296.31 =	2	421
49	= 756.18 =	1	319	85	=1311.74 =	2	437
50	= 771.61 =	1	334	86	=1327.18 =	3	15
51	= 787.04 =	1	350	87	=1342.61 =	3	30
52	= 802.48 =	1	365	88	=1358.04 =	3	45
53	= 817.91 =	1	380	89	=1373.47 =	3	61
54	= 833.34 =	1	395	90	=1388.91 =	3	76
55	= 848.77 =	1	411	91	=1404.34 =	3	92
56	= 864.21 =	1	427	92	=1419.77 =	3	107
57	= 879.64 =	2	5	93	=1435.20 =	3	123
58	= 895.07 =	2	20	94	=1450.64 =	3	138
59	= 910.50 =	2	36	95	=1466.07 =	3	154
60	= 925.94 =	2	51	96	=1481.50 =	3	169
61	= 941.37 =	2	66	97	=1496.93 =	3	184
62	= 956.80 =	2	82	98	=1512.37 =	3	200
63	= 972.23 =	2	97	99	=1527.80 =	3	215
64	= 987.67 =	2	113	100	=1543.23 =	3	230

Standard Regains.

Fibre	Regain (per cent. of dry weight)
Cotton	$8\frac{1}{2}$
Worsted Yarns	$18\frac{1}{4}$
Worsted Tops, in oil	19
Worsted Tops, dry	$18\frac{1}{4}$
Woollen Yarns	17
Wool, scoured	16
Wool Noils	14
Worsted and Woollen Cloths	16
Shoddy	13
Silk	11
Flax and Hemp	12
Jute	$13\frac{3}{4}$

Atmospheric Pressure.

The pressure of :

		per sq. in.	per sq. cm.
$\frac{1}{2}$	stmosphere is	7.348 lb.	.5144 kilos
1	,,	14.696 ,,	1.0287 ,,
$1\frac{1}{2}$	,,	22.044 ,,	1.5431 ,,
2	,,	29.392 ,,	2.0574 ,,
$2\frac{1}{2}$	,,	36.740 ,,	2.5718 ,,
8	,,	44.088 ,,	3.0862 ,,
$3\frac{1}{2}$	,,	51.436 ,,	3.6005 ,,
4	,,	58.784 ,,	4.1148 ,,

FOREIGN CURRENCY, WEIGHTS & MEASURES.

The Value given is that at par. Current quotations can be obtained from the daily newspapers.

Country.	Money.	Weights and Measures
Argentine ..	100 centavos=1 peso (gold)=4s.app.	Metric system.
Austria ..	100 groschen=1 Aust. schilling=7d. app.	Metric system.
Belgium ..	100 centimes=1 Fc. 5 Fcs.=1 Belga =7d. app.	Metric system.
Brazil	1,000 reis=1 milreis=2s. 3d... ..	Metric system.
Bulgaria ..	100 stotinki=1 leva=¼/½d. app. ..	Metric system.
Canada and Newfoundland	100 cents=1 dollar=4s.2d. app. ..	As Gt. Britain, except 1 cwt.= 100 lb. 1 ton.=2,000 lb.
Ceylon ..	100 cents=1 rupee=1s. 6d.	As Gt. Britain, also 1 maund= 40 seers=82 lb. app.
Chile	100 centavos=1 peso=6d. app. ..	Metric system.
China	Silver Standard Currency conditions are chaotic.	1 picul=100 catties=133⅓lb. 1 chang=141 ins.
Czecho-Slovakia	100 heller=1 krone=1.46d. app. ..	Metric system.
Denmark, Norway, Sweden	100 ore=1 krone=1s.1¼d. app. ..	Metric system.
Egypt and Sudan	100 milliemes=1 piastre. 100 piastres =£E=£1, 0s. 6¼d. app.	1 okieh=1.3206 oz. 1 rotl= .9904 lb. 1 oke=2.7513 lb. 1 cantar=99.0492 lb. 1 ardeb =43.55 galls.
France ..	100 centimes=1 franc=1.93d.app.	Metric system.
Germany ..	100 pfennings=1 Reichsmark=11¾d.	Metric system.
Greece ..	100 lepta=1 drachma=½d.app. ..	1 oke=2.8 lb. 1 dramion=111 oz.1 oke of capacity=2.34 pints
Holland ..	100 cents=1 gulden=1s.8d. app. ..	Metric system.
Hong Kong ..	100 cents=1 dollar=2s. 1d.	As Gt. Britain.
India	4 pice=1 anna. 16 annas=1 rupee= 1s.6d. 100,000 rupees=1 lakh.	See Ceylon.
Italy	100 centesimi=1 lire=2¼d. app. ..	Metric system.
Japan	10 rin=1 sen. 100 sen=1 yen= 2s. 0½d. app.	1 kin=1.322 lb. avoir.
Latvia ..	100 santimi=1 lat=9½d.	Metric system.
Lithuania ..	100 centu=1 litas=5d. app. ..	Metric system.
Poland ..	100 gross=1 zloty=5½d. app. ..	Metric system.
Portugal ..	100 centavos=1 escudo=2¼d. ..	Metric system.
Roumania ..	100 bani=1 lei=¼d. app.	Metric system.
Russia (U.S.S.R.)	100 kopeks=1 rouble. 10 roubles 1 chervonetz.	40 funts=1 pund=36 lb. 3 arshins=1 sajena=7ft. 1 vedro=2,705 Imp. galls.
Serbs, Croats & Slovenes (Kingdom of)	100 paras=1 dinar=9½d app. ..	Metric system.
Spain	100 centimos=1 peseta=9½d.app. ..	Metric system.
Switzerland ..	100 centimes=1 franc=9½d. app. ..	Metric system.
Turkey ..	40 paras=1 piastre. 100 piastres= £T=18s.	Metric systen (Used by Customs).
U.S.A. ..	100 cents=1 dollar=4s.2d.	As Gt. Britain, except 1 wine gall.=.833 Imp.galls. 1 ale gall=1,01695 Imp. galls. Cental=100 lb. Short-ton= 2,000 lb. Long ton=2,240 lb.

Coins as Weights.

¼ oz. (4 drams)	= 1 halfpenny and one threepenny piece or one shilling and one threepenny piece.
½ ,, ...	= 2 halfpennies and one farthing or one half-crown.
1 ,, ...	= 3 pennies (for 5 halfpennies).
2 ,, ...	= 6 pennies (or 10 halfnennies).
Threepenny piece	= 22 grains (approx.).
Sixpenny piece	= 44 ,, ,,
Shilling ..	= 87 ,, ,,
Florin	=174 ,, ,,
Half-crown ..	=218 ,, ,, (= ½ oz.).

Weights.

1 lb.	= 16 oz.	= 256 drm.	=7,000 gr.	=454 grm.
1 oz.	=16 drm.	=437.5 gr.	=28.35 grm.	
1 grm	=15.43 gr.	=1 gr.	=0.0645 grm.	
1 kg.	=35.27 oz.	=2.2 lb.		

Measures.

1 gall.	=4 qt.	=8 pt.	=32 gills*	=10lb.	=4.5 olitres
1 pt.	=1¼ lb.	=568 c.c.	=20 fl. oz.		
1 litre	=0.22 gall.	=1.76 pt.	=35.2 fl. oz.		
1 metre	= 3.3 ft.	=39.37 in.			
1 yard	=9.44 cm.				
1 in.	=2.54 cm.				

* In the North of England 1 gill = ½ pt.

The Metric System.

1 metric (m) = 100 centimetres (cm) = 1000 millimetres (mm)
1 litre (l) = 1000 cubic centimetres (cc)
1 ton (t) = 1000 kilogrammes (kg)
1 kilogram(kg) = 1000 grammes (g)

English Weights and Measures.

1 yard =3 feet =0.9144m.
1 foot =12 inches.
1 inch = 2.540 cm.
1 gallon =4 quarts =8 pints = 32 gills =4.546 litres.
1 pound (lb) =16 ounces (oz) = 453.59 g.
1 ton =20 hundred weights (cwt) =2240 lb. =1016 kg.

Facts Worth Nothing.

1 pint	aniline oil	weighs	1 lb. 4½ oz.
,	D.O.V.	,,	2 lb. 3 oz.
,,	nitric acid (coml.) ..	,,	1 lb. 11½ oz.
,,	spirits of salt ..	,,	1 lb. 7 oz.
,,	caustic soda 53° Tw.	,,	1 lb. 8 oz.
,,	acetic acid (30%) ..	,,	1 lb. 5 oz.

1 lb. aniline oil =440 c.c. =three-quarters pint (good).
,, D.O.V. = 250 c.c. =two-fifths pint.
,, nitric acid =325 c.c. = half pint (good).
,, spirits of salt =390 c.c. = three-fifths pint (good).
,, caustic soda 53° Tw. =350 c.c. = half pint (good).

10 parts soda crystals =3.7 parts soda ash.

10 ,, D.O.V. 168° Tw. =22 parts spirits o salts 32°Tw. =40 parts acetic acid 9° Tw.

10 ,, potash alum =6 parts sulphate of alumina.

5 ,, common salt =6 parts desiccated Glauber's salt =13½ parts crystalline Glauber's salt.

1 oz. tartaric acid =2½ oz. lactic acid =¾ oz. oxalic acid =9 drm. D.O.V.

TEMPERATURE EQUIVALENTS OF SATURATED STEAM AT SEA LEVEL

100 lb./sq. in.=7.03 kg.(sq cm. 1 lb./sq.in.=0.07 kg./sq.cm. (approx.)

GAUSE PRESSURE		APPROXIMATE TEMPERATURE		GAUGE PRESSURE		APPROXIMATE TEMPERATURE	
Lb./sq. in.	Kg./sq.cm.	°C.	°F.	Lb./sq.in.	Kg./sq.cm.	°C.	°F.
0	0	100	212	68	4.78	157	314
5	0.35	109	227	70	4.92	158	316
10	0.70	115	239	75	5.27	160	320
15	1.06	121	250	80	5.62	162	324
20	1.41	125	258	85	5.98	164	327
22	1.55	127	261	90	6.33	166	330
24	1.69	129	265	95	6.68	168	334
26	1.83	131	268	100	7.03	170	337
28	1.97	133	271	105	7.38	172	340
30	2.11	134	274	110	7.73	173	344
32	2.25	136	277	115	8.09	175	347
34	2.39	138	280	120	8.49	177	350
36	2.53	139	282	125	8.70	178	352
38	2.67	140	285	130	9.19	180	356
40	2.81	141	287	135	9.49	181	358
42	2.95	143	290	140	9.84	183	361
44	3.09	144	292	145	10.19	184	363
46	3.23	145	294	150	10.55	186	366
48	3.37	147	296	155	10.90	187	368
50	3.51	148	298	160	11.25	188	370
52	3.66	149	300	165	11.60	190	373
54	3.80	150	302	170	11.95	191	376
56	3.94	151	304	175	12.30	192	378
58	4.08	152	305	180	12.65	193	380
60	4.22	153	307	185	13.01	194	381
62	4.36	154	309	190	13.36	196	384
64	4.50	155	311	195	13.71	197	387
66	4.64	156	312	200	14.06	198	388

PERCENTAGE TABLE OF COMMON CHEMICALS

Twaddell	PERCENTAGE OF Sulphuric acid	Nitric acid	Caustic soda	SO2 in sodium bisulphite	Twaddell	PERCENTAGE OF Sulphuric acid	Nitric acid	Caustic soda	So2 in sodium bisulphate
0	0.9	0.2	0	0	61.6	40.2	48.6	27.80	21.0
1.4	1.9	1.5	0.61	0.4	64.0	41.6	50.7	28.83	22.5
2.8	2.8	2.6	1.20	0.85	66.4	43.0	52.9	29.93	23.0
4.4	3.8	4.0	2.00	1.3	69.0	44.4	55.0	31.22	23.6
5.8	4.8	5.1	2.71	1.75	71.4	45.5	57.3	32.47	—
7.4	5.8	6.3	3.35	2.2	74.0	46.9	59.6	33.69	—
9.0	6.8	7.6	4.00	2.65	76.6	48.3	61.7	34.96	—
10.2	7.8	9.0	4.64	3.1	79.4	49.8	64.5	36.25	—
12.0	8.8	10.2	5.29	3.5	82.0	51.2	67.5	37.47	—
13.4	9.8	11.4	5.87	3.9	84.8	52.8	70.6	38.80	—
15.0	10.8	12.7	6.55	4.35	87.0	54.0	74.4	39.99	—
16.6	11.9	14.0	7.31	4.8	90.6	55.4	78.4	41.41	—
18.2	13.0	15.3	8.00	5.25	93.6	56.9	83.0	42.83	—
20.0	14.1	16.8	8.68	5.7	96.6	58.3	87.1	44.38	—
21.6	15.2	18.0	9.42	6.25	99.6	59.6	92.6	46.15	—
23.2	16.2	19.4	10.06	6.8	103.0	61.0	96.0	47.60	—
25.0	17.3	20.8	10.97	7.3	106.0	62.5	98.0	49.02	—
26.8	18.5	22.2	11.84	7.8	109.2	64.0	100.0	—	—
28.4	19.6	23.6	12.64	8.4	112.6	65.5	—	—	—
30.4	20.8	24.9	13.55	9.0	116.0	67.0	—	—	—
32.4	22.2	26.3	14.37	9.6	119.4	68.0	—	—	—
34.2	23.3	27.8	15.13	10.2	123.0	70.0	—	—	—
36.0	24.5	29.2	15.91	10.85	127.0	71.6	—	—	—
38.0	25.8	30.7	16.77	11.5	130.0	73.2	—	—	—
40.0	27.1	32.1	17.67	12.2	134.0	74.7	—	—	—
42.0	28.4	33.8	18.58	12.9	138.2	76.4	—	—	—
44.0	29.6	35.5	19.58	13.7	142.0	78.1	—	—	—
46.2	31.0	37.0	20.59	14.5	146.4	79.0	—	—	—
48.2	32.2	38.6	21.42	15.2	150.6	81.7	—	—	—
50.4	33.4	40.2	22.64	15.9	155.0	84.1	—	—	—
52.6	34.7	41.5	23.67	16.85	159.0	86.5	—	—	—
54.8	36.0	43.5	24.81	17.8	164.0	89.7	—	—	—
57.0	37.4	45.0	25.80	18.7	168.4	396 0	—	—	—
59.4	38.8	47.1	26.83	19.6					

INTERNATIONAL ATOMIC WEIGHTS & THEIR LOGARITHMS

Element.	Symbol.	At. Wt.	Log.
ALUMINIUM	Al	27.1	1.43297
ANTIMONY	Sb	120.2	2.07990
ARGON	A	39.9	1.60097
ARSENIO	As	74.96	1.87483
BARIUM	Ba	137.37	2.13789
BERYLLIUM	Be	9.1	0.95904
BISMUTH	Bi	208.0	2.31806
BORON	B	10.9	1.03743
BROMINE	Br.	79.92	1.90266
CADMIUM	Cd	112.40	2.05077
CAESIUM	Cs	132.81	2.12323
CALCIUM	Ca	40.07	1.60282
CARBON	C	12.005	1.07936
CERIUM	Ce	140.25	2.14690
CHLORINE	Cl	35.46	1.54974
CHROMIUM	Cr.	52.0	1.71600
COBALT	Co	58.97	1.77063
COLUMBIUM	Cb	93.1	1.96895
COPPER	Cu	63.57	1.80325
DYSPROSIUM	Dy	162.5	2.21085
ERBIUM	Er	167.7	2.22453
EUROPIUM	Eu	152.0	2.18184
FLUORINE	F	19.0	1.27875
GADOLINIUM	Gd	157.3	2.19673
GALLIUM	Ga	70.1	1.84572
GERMANIUM	Ge	72.5	1.86034
GLUCINUM (Beryllium)	Gl	9.1	0.95904
GOLD	Au	197.2	2.29491
HELIUM	He	4.0	0.60206
HOLMIUM	Ho	163.5	2.21352
HYDROGEN	H	1.008	0.00346
INDIUM	In	114.8	2.05944
IODINE	I	126.92	2.10353
IRIDIUM	Ir.	193.1	2.28578
IRON	Fe	55.84	1.74695
KRYPTON	Kr	82.92	1.91866
LANTHANUM	La	139.0	2.14302
LEAD	Pb	207.2	2.31639
LITHIUM	Li	6.94	0.84136
LUTECIUM	Lu	175.0	2.24304
MAGNESIUM	Mg	24.32	1.38596
MANGANESE	Mn	54.93	1.73981
MERCURY	Hg	200.6	2.30233
MOLYBDENUM	Mo	96.0	1.98227
NEODYMIUM	Nd	144.3	2.15927
NEON	Ne	20.2	1.30535
NICKEL	Ni	58.68	1.76849
NITON	Nt	222.4	2.34714
NITROGEN	N	14.008	1.14638
OSMIUM	Os	190.9	2.28081
OXYGEN	O	16.0	1.20412
PALLADIUM	Pd	106.7	2.02816
PHOSPHORUS	P	31.04	1.49192
PLATINUM	Pt	105.2	2.29048
POTASSIUM	K	39.1	1.59218
PRASEODYMIUM	Pr	140.9	2.14891
RADIUM	Ra	226.0	2.35411
RHODIUM	Rh	102.9	2.01242
RURIDIUM	Rb	85.45	1.93171
RUTHENIUM	Ru	101.7	2.00732

INTERNATIONAL ATOMIC WEIGHTS & THEIR LOGARITHMS—Contd.

Element.	Symbul	At Wt	Log.
SAMARIUM	Sa	150.4	2.17725
SCANDIUM	Sc	45.1	1.65418
SELENIUM	Se	79.2	1.89873
SILICON	Si	28.3	1.45178
SILVER	Ag	107.88	2.03294
SODIUM	Na	23.0	1.33173
STRONTIUM	Sr	87.63	1.94265
SULPHUR	S	32.06	1.50596
TANTALUM	Ta	181.5	2.25888
TELLURIUM	Te	127.5	2.10551
TERBIUM	Tb	159.2	2.20194
THALIUM	Tl	204.0	2.30963
THORIUM	Th	232.15	2.36577
THULIUM	Tm	168.5	2.22660
TIN	Sn	118.7	2.07445
TITANIUM	Ti	48.1	1.68215
TUNGSTEN	W	184.0	2.26482
URANIUM	U	238.2	2.37694
VANADIUM	V	51.0	1.70757
XENON	Xe	130.2	2.11461
YTTERBIUM	Yb	173.5	2.23930
YTTRIUM (Neoytterbium	Yt	89.33	1.95100
ZINC	Zn	65.37	1.81538
ZIROONIUM	Zr	90.6	1.95713

1 inch = 2.51 centimeters.

1 yard = .9144 meters.

1 sq. yard =.8361 square meters.

1 centimeter = .3937 inches.

1 meter = 39.37 inches or 1.0936 yards.

1 sq. meter = 1.196 square yards.

1 grain = .0648 grains.

1 ounce = 28.35 grams

1 pound = 453.6 grams.

1 gram = 15.43 grains.

1 kilo = 2.204 pounds.

1 denier = 105 grams or .7715 grains.

1 kilo per 100 sq. meters = 54.25 sq. yards per pound.

To Determine the Capacity of a Cylindrical Vessel

The diameter is multiplied by itself and the product is multiplied by the standard number :—

0.785

This multiplied by the depth of liquor gives the volume in cubic feet.

Example—

Diameter : 4 ft. Depth of Liquor: 2 ft.

4 ft. × 4 ft. = 16 sq. ft.
16 × 0.785 = 12.56 sq. ft.

This result is multiplied by the depth of the liquor : 2ft. × 12.56 sq. ft. = 25.12 cu. ft. (1 cu. ft. = 6.25 gallons).

∴ 25.12 cu. ft. = 25.12 × 6.25 galls. = 157 galls.

To Determine the Capacity of a Rectangular Vessel

The length multiplied by the breadth, multiplied by the depth of liquor gives the cubic content.

The cubic content is then multiplied by 6.25 to convert cubic feet into gallons.

Example—

Dimensions of the dye vessel :—

10 feet long.
2½ feet wide.
3 feet deep.

10 × 2½ × 3 = 75 cu. ft.
75 cu. ft. × 6.25 = 468.75 galls.

Hardness of Water

Hardness in water is due mainly to the presence in solution of various compounds of calcium and magnesium. It is customary and necessary to distinguish between two kinds of hardness; (*a*) carbonate hardness and (*b*) non-carbonate hardness. The former is known as Temporary hardness and the latter as Permanent hardness.

Carbonate hardness is due to the presence of bi-carbonates of calcium and magnesium. It is for the most part destroyed by boiling, and it is for this reason that it is often called temporary hardness.

Non-carbonate hardness is due to the presence of the sulphates, chlorides, and nitrates of calcium and magnesium. It is not destroyed by boiling at atmospheric pressure, and it is therefore often called permanent hardness.

For correcting water, for every English degree of hardness and for every 100 gallons of water used :—

In order to express the hardness of water quantitatively it is usual to calculate the calcium and magnesium compounds present in terms of their equivalent of calcium carbonate ($CaCO3$). The hardness is then stated in terms of "grains $CaCO3$ per gallon" (degrees of hardness) or "parts $CaCO3$ per 1,00,000." The latter method of expression is widely used in this country at the present time.

" Parts $CaCO3$ per 1,00,000" when multiplied by 0.7 gives the hardness in 'degrees.'

Calcium and magnesium compounds react with soaps in solution forming insoluble soaps which separate out as a sticky curd-like deposit. The soluble soap which is thus acted upon is of no value for washing and scouring purposes, and the precipitated calcium and magnesium soaps adhere tenaciously to the washed fabrics, forming streaky deposits and causing the colour and 'feel' to be unsatisfactory. A water of hardness equal to 20 parts per 1,00,000 (14 degrees) will destroy about 20 lbs. of soap per 1,000 gallons.

Hard waters not only lead to wastage of soap, but also have an adverse effect on the efficiency purposes.

For certain purposes the temporary hardness of the water may be corrected by the addition of acetic acid. The amount of acetic acid required will be seen from the following table.

One litre of water is tinted with a trace of methyl orange and then one-tenth normal hydrochloric acid (10 c.c.s. hydrochloric acid 34.2° Tw. per litre of water) is run in from a burette until it is decolourized. The number of cubic centimetres of acid used are then found in the first column of the following table and in the same horizontal lines is given the amount of acetic acid required to correct 100 gallons of the water.

The presence of iron in the water leads to trouble in preparatory, dyeing and finishing processes, but iron is largely removed by treatment with lime and usually a satisfactory water can be prepared without recourse to a full softening process.

Moorland waters, by their acid nature, readily dissolve iron, particularly from the resty interiors of feed pipes; this solvent action is best prevented by the addition of sodium silicate (1 or 2 gr. per gallon) to the supply.

Estimation of Water Hardness.

For estimating the total hardness of a water use an alcoholic soap solution containing 20 grms. of neutral pure white olive oil soap per litre, standardised with a barium chloride solution containing 0.523 grms. pure crystallised barium chloride per litre distilled water. This barium chloride solution, which requires 45 c.c.s. soap solution for every 100 c.c.s., corresponds to water of 15° English hardness.

When testing the hardness of a water, measure 100 c.c.s. with a pippet into glass-stoppered cylinder or flask of about 250 c.c.s. contents, and allow the normal soap solution described above to flow in until the froth formed on shaking remains standing for about 5 minutes. The number of c.c.s. of soap solution used indicates the total hardness of the water according to the following table. If the water is very hard take 10 or 20 c.c.s. dilute to 100 c.c.s. with distilled water, and titrate as above.

1 English degree of hardness =1 part CaCO3 in 70,000 parts water.

1 German degree of hardness =1 part CaCO3 in 1,00,000 parts water

1 French degree of hardness =1 part CaCO3 in 1,00,000 parts water.

No. of c.c. $\frac{N}{10}$ acid required per litre of water	No. of oz. Acetic Acid 30% required per 100 gallons water	No. of c.c. $\frac{N}{10}$ acid required per litre of water	No. of oz. Acetic Acid 30% required per 100 gallons water
1	0.32	26	8.32
2	0.64	27	8.64
3	0.96	28	8.96
4	1.28	29	9.28
5	1.60	30	9.60
6	1.92	31	9.92
7	2.24	32	10.24
8	2.56	33	10.56
9	2.88	34	10.83
10	3.20	35	11.20
11	3.52	36	11.52
12	3.86	37	11.84
13	4.16	38	12.10
14	4.48	39	12.48
15	4.80	40	12.80
16	5.12	41	13.12
17	5.44	42	13.44
18	5.76	43	13.76
19	6.08	44	14.08
20	6.40	45	14.40
21	6.72	46	14.72
22	7.04	47	15.04
23	7.36	48	15.36
24	7.68	49	15.68
25	8.00	50	16.00

Precipitation of Lime in Water

In the case of some colours which are sensitive to lime, it is necessary to precipitate the lime present in the water before dissolving and dyeing.

The following proportions will be found useful.

Per 100 gallons of water.

6° Hardness use 2 ozs. Oxalate of Ammonia,
or $1\frac{7}{8}$ oz. Oxalic Acid neutralized with $2\frac{1}{2}$ ozs. Ammonia 20%.

ANALYSIS OF WATER FOR HARDNESS.

WATER FROM "LOCH LOMOND."

(Per 100000 parts)

Hardness	2.30 parts
Alkalinity	2.00 ,,
Calcuim Carbonate	1.61 ,,
Magnesium ,, ...	0.32 ,,
Magnesium Sulphate	0.40 ,,
Sodium ,, ...	0.76 ,,
Sodium Chloride	1.81 ,,
Total dissolved solids.	4.90 ,,

WATER FROM AHMEDABAD

(Per 100000 parts)

Hardness	32.82 parts.
Alkalinity	42.62 ,,
Calcium Carbonate	17.92 ,,
Magnesium ,, ...	12.52 ,,
Sodium ,, ...	10.42 ,,
Sodium Sulphate	7.88 ,,
Sodium chloride	19.26 ,,
Total dissolved solids	68.00 ,,

Condition of water;—The water contained an appreciable amount of finely divided suspended matter.

Quantity of Softeners to be used

15° Hardness use $4\frac{1}{2}$ ozs. Oxalate of Ammonia,
or $4\frac{1}{4}$ ozs. Oxalic Acid with
$5\frac{3}{4}$ ozs. Ammonia 20%.

23° Hardness use 7 ozs. Oxalate of Ammonia,
or $6\frac{1}{4}$ ozs. Oxalic Acid with
$8\frac{3}{4}$ ozs. Ammonia 20%.

32° Hardness use $10\frac{1}{4}$ ozs. Oxalate of Ammonia,
or $9\frac{1}{2}$ ozs. Oxalic Acid with
13 ozs. Ammonia 20%

CHAPTER L.

SCIENTIFIC COSTING.

COTTON YARN AND FABRIC.

In any Industrial Business one of the most important departments is the costing department, and this is particularly true of the various sections or departments of the "Textile Industry" where competition is very keen.

The person in charge of the costing department is responsible for the cost of production, that is, the cost of converting the raw material into the finished product. Any error committed in finding the cost of a piece of cloth or a pair of Dhoty or Saree may have serious consequences. A mistake may make all the differences between a large order being obtained or lost, or, at least it may convert a narrow margin of profit into an actual loss.

Cloth calculations and costing are very important to Managing-Agent, Managers, Weaving Masters, Cloth-Salesman, Merchants and those intending to occupy such positions where calculations regarding cotton cloth must be performed.

Scientific Costing is the most accurate method of efficient production control. It entails up-to-date departmental records of consumption, production, and costs, it provides forecasts for these and other vital factors in Controlling a business, and it automatically relates all these factors in their proper order to regular trading accounts and balance sheets.

The science of management has developed several functional laws of theoretical and practical value, concerning variations of costs, prices, and profits or losses.

Cost and Profits Statements.

The costs and Profits statements are reliable means for measuring the manufacturing and selling efficiences of every manufacturing concern. From such statements it is known that there exists a marked regularity in corresponding values of costs and output, or

between the yearly amounts of sales and profits. The total expenses or costs of production vary, together with the number of units produced in a given time period, say for a year, a month, or a standard working day. Extensive studies made in various manufacturing concerns have shewn that not withstanding numerous outside and inside influences, these variations follow a simple law, as the total costs per period (time costs) increase uniformly from a certain minimal level with increases of output in the same period.

Cotton Mill Economy.

Cotton mill economy is the most important part of manufacturing management. It is needless to lay any stress on the importance of the fact that however good the product may be, but if it costs too much to manufacture it, it cannot be sold in competition with the manufacturers who are very economical without suffering a loss.

Bear in mind that the production of yarn and cloth are the results of multiplication of processes which gradually form the basis of cost and unless these multiplications are analysed and carefully studied, constant observations made, it is quite possible for the expenditure to be invariably calculated and added up, which may sometimes be insufficient to repay the cost of production and the sorts produced on such basis cannot be sold without incurring a loss.

Unwise Procedure.

It is indeed very unwise to make a cloth and find the cost afterwards as is the case with some of the mills who eventually find themselves to their surprise or when it is too late that they are heading towards a catastrophy. First find the cost and then manufactnre.

When Competing.

A more difficult state of things arises when a given class of goods costing a certain price is to be produced at a cheaper rate. In such event it will be the manufacturer's task to first see what economies he can effect in the cost of the material, either by buying to advantage or introducing a lower quality and then turn his attention to reducing the cost of production for which there is always an opportunity.

Adverse Factors of Economies.

There are always a 'waste of time,' 'waste of materials', 'waste' of motions or energy,' 'waste of transportation,' 'waste of processing 'waste of supplies,' 'waste of repairs,' and many other things, including the wasting of raw materials before manufacturing, while in process, and after the goods are finished.

A Hawk Eye Watch.

If any real saving is to be made and if the little profit that can be made in an, industry is to be prevented from being wiped out by wastage then a hawk eye watch must be kept on all kinds of wastages. There is even an invisible waste caused by the following things—such as dust, moisture, short fibres and other foreign substances. The visible waste may be as follows :—leaf fibres, long and short fibres, sand, seed, etc.

An Idle Machine.

An idle machine is a continual loss so is a machine that is producing inefficiently, as both reduces the production and increases the cost.

A Chief Factor For Profit and Loss.

It requires mighty good judgement to purchase cotton which is one of the chief deciding factors that lead to profit or loss and the gain or loss varies more or less in direct ratio or in proportion to the intensity of wastes.

The economic value of cotton varies a great deal. It must be suitable for the product to be manufactured. If it is better than required, a loss must be sustained. If the price is not right or too high, a loss will ensue. If the percentage of usable fibre runs too low, there surely will be a loss. It makes vast difference as to whether the cotton for one inch staple is pure or mixed up with other short staples, and to what extent. Another important feature to note in the purchasing of cotton is whether the percentage of waste both visible or invisible is high or low. This can be best determined by making frequent tests for waste and moisture from selected bales noting carefully the results, and it should be ascertained what weight is lost and what percentage of that weight is recoverable. The remainder which is irrecoverable is the weight which represents invisible loss. It can be seen at a glance that it does make a vast difference as to whether a bale of cotton makes a 15% waste or 20% waste. The amount of waste must be compared against the purchased price.

Effect of Hedging.

A Mill–owner or Agent must not speculate on account of the mill under his control. As a rule a cotton mill, being purely an industrial concern, should be as free as possible from any element of speculation involving risk of rise and fall of cotton, yarn or cloth market.

In the sale of cotton goods, a decline in the cotton market will be reflected by a decline in the piece goods market. If a manufacturing concern fixes up a set value of its cotton, without hedging, and when the price of cotton drops down, then the manufacturer must either drop down his price, or stop selling and stock his goods in the hope of getting a better price. The best course for a manufacturer to follow, if he desires to save himself great losses, is to follow the market on its upward or downward trend.

It may be added here that practically all the mills in India make large sales of cloth in the months of October–November (being Deepawali or Pooja holiday).

January—February (being a season for marriages) and on a limitted scale in June–July, lest they may be deprived of their regular customers, the local conditions make it imperative for them to make forward sales of yarn and cloth at the above periods.

Likewise the heavy arrivals of first picking cotton in the early part of the cotton season make it imperative or absolutely necessary for some of the mills to make large purchases of cotton within a month or two, failing which the mills (that are chiefly situated near cotton growing fields) run the risk of losing the major portion of the superior grade of cotton particularly required by them for their standard mixings or finer mixings In order, therefore, to avoid the risk of rise and fall in the cotton market a suitable medium of hedge is highly desirable in the interests of the mills.

It is advisable for a mill owner to cover at least half the requirements of his sales of yarn or cloth with purchases of cotton either ready or forward whichever may be profitable at the time.

Watch Fluctuations by means of a Chart.

Those mills that are situated round about cotton growing fields are well advised to buy either part or half of their requirements ready cotton of first picking selected stuff, which may not be available in unmixed form later on, and the rest of their requirements be left uncovered. But the authority responsible for purchasing cotton must bear in mind that the uncovered requirements of cotton must not be shelved or forgotten or looked at indifferently. It is absolutely necessary that they should watch the fluctuations of the

market by means of a chart. Study or rather analyse the causes or the circumstances under which the fluctuations are influenced or taking place and the difference in prices between ready and forward cotton in various markets and particularly in his own market also the factor that other speculative markets, such as silver, shares, seeds, etc. has also a bearing on cloth or cotton market must not be lost sight of.

By a study of the annual fluctuations charts, it is generally seen that cotton prices gradually take a downward trend from February onwards till May, after which they again begin to rise. The month of May, particularly, is considered as the month when the lowest prices for the year are generally seen. During this period it also happens that the mills have to make heavy purchases of first picking ready cotton for their annual consumption.

The mills can have no hedge contract to depend on for sales of yarn and cloth during the months of June–July. The period following these months till the arrival of new crop in November. December is the most critical and uncertain period of the year. It is during this period that various Bureau reports of the new American crop arrive and monsoonish uncertainty prevails in the market. Great caution and foresight is therefore necessary to be exercised in entering upon any business of new crop as hedge against sales for which the mills have to buy old crop. The months of July–August are months of reckoning and adjusting accounts amongst cloth merchants in general and hence they should be considered quiet months.

Material Control.

The next phase of material control is that of deciding the cotton position. It is important that a manager should know constantly whether his cotton position is long or short relative to his orders, and an account should be kept at its yarn equivalent. This may well facilitate the operation. Perhaps the simplest method of controlling material in this respect is to treat the figures in the form of an account, commencing by placing on one side of the account the weight of yarn required or on order, less the weight of yarn in stock, and adding at fixed intervals the weight of yarn consumed or sold. On the other side of the account is placed the cotton held, including that in process or not, and to this figure is added the weight of cotton purchased, both of which are reduced to yarn equivalent. The account should embrace the whole of a trading period, and may be extended to show the position in each separate quality or counts of yarn required or sold.

Diseased Machinery of Accounts.

It is a well known fact in the practice of medicine that the earlier a disease can be recognized, the greater the possibility that it can be dealt with successfully. This is equally true of the ailments of unsound method of costing, though not always realized.

Diseased machinery of accounts perhaps is an unusual descriptive term and yet every informed man knows that much machinery delivers less than its full capacity and eventually fails of some hidden maladjustment or disease.

Datas For Costing.

In presenting the datas to the reader for the purpose of arriving at accurate cost whether per lb., per piece, or per yard of a piece or length of cloth, the writer has endeavoured to do so in as easy and comprehensive manner as possible with regard to their details and he hopes that the reader may understand and follow them without any difficulty. Figures developed by sound cost calculations are the only and the best way in which a mill and its managing agents, or selling agents can know the comparative cost of the different yarns or cloth it intends to manufacture without this knowledge a mill may continue to make less profitable products and its selling agency may continue to be contented to sell them at prices disproportionate to their costs. It mattered nothing whether the problem appertained to spinning or manufacturing unless details and technicalities were mustard and results tabulated, a producer was always under a handicap.

Regular Comparison is Most Essential.

It is only by regular comparison that faults and weak points can be discovered. By dissecting the manufacture of yarn into processes and obtaining productions, wages, expenses costs and percentage month by month, inefficiencies will be located. Again, by the aid of cost reports and statistics, the management can decide whether making of certain products increases overhead expenses disproportionately, whether the plant and machinery could be used more advantageously by concentrating on particular products to the exclusion of less profitable ones. It also provides a basis upon which to calculate selling prices thus preserving the manufacturer from that contemptible position of merely quoting his competitors prices, because he is unable to obtain his own. Further knowing real costs of production, a manufacturer can fix the lowest margin

of profit on the reduced output when quoting; or, when embarking on a policy of cutting his prices, to increase turnover with the object of avoiding the loss of at least some of those overhead expenses which are irreducible. Such a policy could not continue for an indefinite period, but may be justified during a trade depression until a revival of business occurs, in that whilst loss may be suffered, the loss would otherwise be heavier.

A further advantage of sound and accurate cost figures is that they afford an invaluable guide to the efficiency of the mill organization and aid in bringing to light efficient or less efficient methods which otherwise might be lost sight of. Besides it provides the necessary control to enable a producer to know at any time whether the enterprise in which he is engaged is standing upon a firm or upon infirm foundation.

Standard Cost.

It is emphatically necessary to point out that no uniform "Standard Coct" can be laid down for the general use of manufacturers. The author has come across certain manufacturer who argued that double weaving rate (what is paid to the weaver) or $\frac{3}{4}$ weaving rate plus one anna per lb. for size was enough for the manufacturing or overhead cost. There are also other manufacturers who take six annas or four annas or two annas for overhead or manufacturing charges per pound or piece.

The reader can see for himself how misleading it is to base the overhead charges stated in the preceding paragraph without considering each individual quality of cloth on its merits and without reckoning the actual expenses.

For an example if the overhead charges or manufacturing cost (which is found from actual expenses such as agents commission, officers and clerks wages, tax, interest, insurance, fixed wages, cotton cess, salesmen commission and expenses, railway expenses etc. etc.) in a mill works out to be Rs. 1-4-0 per loom per day and if there are three qualities under consideration for costing purposes and suppose the production per loom of No. 1 Sort is 2 lbs. per day per loom and No. 2 sort is 10 lb. per day per loom and No. 3 sort is 20 lbs. per loom per day. Therefore the manufacturing cost of No. 1 would be (20 annas ÷ 2 lbs) = 10 annas per lb. No. 2 would be (20 annas ÷ 10 lbs) = 2 annas per lb. and No. 3 would be (20 annas ÷ 20 lbs) = 1 anna per lb.

The reader may now judge for himself the difference in rates that are found out systematically and those that are reckoned on guess work or flat rates and the consequence of adopting figures unsystematically. A practice still resorted to in some of the mills, is to divide the total expenditure by the actual production in pounds and to assume that this represents the cost per pound and then to divide this cost per pound by the yards per pound for a particular fabric and to assume that the result represents the cost per yard or pound or piece of that fabric. This method, of course, ignores every differentiating circumstances in the business, whereas, at practically every stage of manufacture, the production of every distinct yarn numbers or counts or weaving of cloth involves differences in relative expenditure of labour and overhead charges. Hence, this method is a complete negation of the theory of cost finding except when a mill confines itself exclusively and invariably to the making for sale of a single yarn count or to the weaving of a single kind of cloth.

It is absolutely necessary for each individual manufacturer to ascertain the exact cost at his own particular mill from facts and figures. It is very difficult to find two mills where the cost may be alike although they may be engaged on similar classes of goods. Carelessly—Controlled business are a danger, not only to themselves, but also to others. If productive costs are not computed or reckoned with reasonable accuracy then underselling may take place and people making similar goods may be induced to lower prices to an unprofitable figure to compete with the prices set. Such a business is a trade derelict, for just in the same manner that a derelict is a menace to ships sailing a true course, so it is a danger to business concerns which are running along business lines.

Replacement Cost.

'Replacement Cost' instead of book value of cotton, should be used in the predetermination of costs for the purpose of costing. In view of the fluctuating prices for such raw materials, a sound policy on this point is of the greatest importance. A mill is justified in assuming that the raw material it uses have the market value current at the time of sale of its prodyct, and indeed, the mill cannot proceed with confidence and accuracy upon any other principle. Raw cotton has a market value which must always be considered at the time of selling of product of the mill whether be it old stock or to manufacture forward or at some future date. For an example, if a manufacturer has bought cotton at 12 annas per pound and the

value has depreciated to 10 annas per pound, then at the time of making a fresh sale the price of the cotton should be taken as ten annas and not twelve annas, and vice versa.

Not only is this sound from the stand point of the facts, but it is highly important from the standpoint of merchandising policy because any other method involves the mill in misleading itself as to the significance of the cost of the raw materials with reference to the price of the product. If at the time of sale of its product, the raw material has declined in price since its purchase, the mill cannot on that account get a price for its goods which will reflect the higher price it paid at an earlier date for its raw material. The mill must yield to the prevailing price levels of the market and these almost invariably reflect any declines that may have taken place in the price of cotton.

If, at the time of sale of its product, the raw material has increased in price, the raw material is worth as 'material' that present value and if the price of the products reflect, as it should, the current value of the raw material the mill, should not omit to profit by that condition. It may be true that very frequently the price of cotton products fail to reflect the increase in price of cotton, but the mill should not accumulate the unfortunate tendency by deliberately disregarding the fact that, at the time of sale of its goods, the product should be charged with the then value of the raw materials.

Replacement Cost must be Considered.

If a mill disregard the replacement cost of cotton at the time it sells its goods, and seeks to predetermine its costs on the basis of what it had paid for cotton, it not only disregards the fact as to what it could get for the raw cotton if it sold instead of making it into goods, but it also comits itself to a rule of cost predetermination which will tend to affect it detrimentally whichever way cotton prices move, if the price of cotton declines, market conditions will compel reduction in the price of the goods despite the fact that the mill reckon its predetermined costs on the book value of cotton, but if the cost of cotton increase, the mills' method of predetermining costs will not only have no tendency to help the mills position as to the price of its goods, but will have the adverse position through under valuing the true cost of the cotton which is manufactured into cloth, as that cost stands on the date of such sale.

A question may arise that if replacement cost of raw materials is always to be taken for the purpose of finding out the cost price of the manufactured article, then how is the finance side of the book to

be reconciled with the cost price? The answer is that the costing should be worked out in two ways:—(1) Find the cost price by taking the true or book value of the raw material. (2) Find also side by side the cost by taking the replacement value and then enter the difference either on the profit or loss side.

What Purpose Does Costing System Serve.

A costing system should serve a double purpose; in the first place it should provide data upon which can be based the cost estimate. The cost estimate may be described as the measuring unit which will be placed against the actual cost for the purpose of comparison. It should be prepared with great care, and should be calculated upon good average running conditions as far as production is concerned. In the second place, it should provide sufficient detail to make possible a comparison of each factor process by process as the work of production proceeds. When productions have been calculated from the first to the last process and have been proved to be reasonable, no, no effort should be spared to bring the actual cost into line with the estimated one.

It may be that production is being lost through one reason or the other, and a careful investigation will probably find the clue to the mystery. It may be that indirect labour is excessive, investigation again will lead to the elimination of such excess, or it may well be that stores are being wastefully used, when an enquiry will exercise a strong moral effect upon those concerned, and should certainly stop the evil. An examination must be made of each weak place in turn, and the causes of the weakness must be removed until the actual costs of production and the estimated costs are as nearly as they can be made identical.

If a mill owner or an agent is a shrewed buyer of cotton, he is bound to make more money on the rising price of the cotton than he will do on the selling price of his finished goods as based on manufacturing costs. But in the event that he has bought cotton at a higher rate and he is obliged to sell his manufactured goods at a lower rate of cotton ruling at the time, then the best course for him is to cover his sales by a fresh purchase of cotton at the current rate for an equal quantity.

Method of Costing

There are two methods of costing, namely :—(*a*) the "Standard manufacturing Cost," (*b*) the "Actual Cost."

By the "Standard or Manufacturing Cost" is meant that the cost of production during a normal working of a mill over a normal period of time.

By the "Actual Cost" is meant the actual amount of money spent for production at any time, whether during curtailment, or during a time of unusually low expenditures and good production. It is absolutely necessary to establish a 'Standard working' base for the purpose of quoting for the manufactured goods that are to be sold. The standard basis when once fixed up after being verified very carefully, should not be changed for each slight change in the actual expenditure.

The standard cost must cover all phases of expense, and the average must be taken of a sufficiently long period in order to arrive at an accurate figure based on 'facts' and by comparison with work that is accomplished with 'facts.'

"*Fundamental Data*" *Consists of ;—*

(*a*) Expenses.
(*b*) Production (should be of maximum efficiency)

"*Overhead Cost*" *consists of ;—*

(*a*) Standing expenses and working expenses.
(*b*) Interest, depreciation and income tax.
(*c*) Workmen quarters.

"*Facts that can affect the Standard Base of Costing.*"

(*a*) Change in the mill conditions.
(*b*) Excessive waste.
(*c*) Change in the management of the mill.
(*d*) Increase of taxes, interest on investment.
(*e*) Salaries and wages.

Labour Cost

The most important items of expenditure are as follows :—

(*a*) Direct Labour cost.
(*b*) Indirect Labour cost.
(*c*) Power Expense.
(*d*) Stores Expense.

There are two kinds of "labour"......the "fixed wage labour" and the "piece work labour"....or "Indirect" and "Direct labour."

By fixed wage labour is meant that the operative receives a fixed wage, such as officers, overseers, or assistants, clerks, head jobbers, jobbers (Spinning department), carpenters, fitters, coolies, sweepers, watchmen etc.

By piece-work labour is meant that the work people receive wages on the outturn or whatever he or she produces.

The basis ot control is the accurate measurement of human labour and the expenditure incurred to obtain a result from them.

Store Issues should be Regulated

As the labour cost is regulated so the stores should be systematised. There should be an inventory system, which will show the issues and the stock on hand.

Check on the Production

The actual money spent on the production is only one of the two important factors that determine the final cost on the fabric. The production is the other. In addition to a check being made on the expenses, a check must also be made on the efficiency of the proproduction.

Production Efficiency

The organisation of a factory or mill has for its object efficient production......This efficiency being measured by the number of articles or product, manufactured, the quality and price of the product, and the quickness of delivery. The requirements for successful competition are that production must be expeditions, correct, and at a minimum cost.

The attainment of these objectives demands careful organisation, good management, and the fullest use of plant and the other agents of production. The inclusion of a system of costing provides a reliable means of measuring the extent to which the management succeeds in achieving these objectives.

Important Factors to be Noted While Quoting a Price of Cloth

(1) Heavy or coarse counts can be manufactured at a cheaper cost per pound than fine yarns.

(2) The labour and overhead cost on the coarse yarns will be much lower due to the fact that more pounds of the coarse yarn than of fine yarn can be turned out in a given time.

(3) If two sorts were the same except for counts of yarn that would be enough by itself to affect cost per pound.

To Test Cost System for Accuracy

(*a*) All the facts and figures collected for the purpose of fixing up the "Standard Cost" or the "manufacturing cost" must be correct.

(*b*) The production figure must be checked for its accuracy and must represent a normal run or period.

(*c*) The cost of fuel or coal, stores and wages must be distributed to the various departments in a correct manner.

(*d*) To ensure reliable statistics, every original entry on factory forms or reports should be supported by an examiner's or checker's signature or counter-checks.

(*e*) Promptitude, frequency, and regularity in the presentation of statistics and accounts must be arranged for.

(*f*) The Cost Accounts and Financial Accounts should be either interlocked in one integral accounting scheme, or so arranged that the results shown by the two sets of accounts can be reconciled.

Approximate Percentage for Depreciation

6%	on	Engines
10%	,,	Boilers
8 %	,,	Machines
5 to 6 %	,,	Gearing etc.
45 %	,,	Belting

$2\frac{1}{2}\%$ on Buildings.
5 % ,, Spinning and Weaving machinery.
$7\frac{1}{2}\%$,, Finishing machinery and Electrical equipment.
4 % ,, the total fixed capital expenditure including land workmen's Chawls etc.

Additional allowance of, say $7\frac{1}{2}\%$ must be made if the mill is working double shift.

Depreciation and its Application

When productive equipment or the machinery is worn out or becomes obsolute it must be replaced, and the only safe method to do so is to provide for it in the cost of production or the manufacturing cost. It is very wise policy to allow as liberal an allowance as the circumstances will permit, as such a policy tends to strengthen the financial position of a concern by creating hidden reserve. Any mill or industry that ignores or fails to provide adequately for depreciation in the manufacturing cost whether the trade is in a prosperous condition or otherwise, will eventually find itself on the road of disaster. The determination of proper percentage for depreciation requires a keen study of the individual mill, its hours of operation and its working conditions.

When the amount of depreciation has been determined, the question of its application will arise, thus, it may represent the decrease in value of the physical part of the plant, and is deductable from the book value to obtain the present worth, it may be taken as the amount of the capital investment which is worn out, and is a charge against manufacturing costs, or it is the amount which should be set aside as a reserve each year to replace the original machine, or its equivalent, when it is worn out.

The depreciated value, which is found by deducting the total depreciation from the replacement or original costs, gives a figure which may have little or no relation to actual value. Changes in the industry, such as drastic changes in costs of machinery, over-expansion, under-consumption or other agencies may deflate values to a point below book values; or contrary changes may increase market values above book values. The depreciation must be based on fair book values as represented by actual expenditures for machinery.

When the amount of annual depreciation of textile machinery is set aside each year as a reserve to place the machinery on its retirement, there are some other factors to be considered. During the

useful life of a machine there is likely to be considerable change in its cost, due to changing commodity price or to improvement in the machine which increase its cost.

The accrued amount at its retirement should be sufficient to replace it. Depreciation for this purpose should be figured on replacement costs. Evidently new book values cannot be established each year, but they can, and should be corrected at reasonable intervals to keep book values somewhat in line with equal replacement costs. In this way the reserve set-up will actually replace the machine on its retirement at the then existing cost. Because of the intermediate factor of obsolescence, this can be only approximate.

Schemes of Figuring Depreciation

Many Schemes of figuring depreciation on machinery have been evolved, but in general, two methods are used. One is the straight line method, in which the same amount of depreciation is taken each year from the time of its installation producing a reserve of constant growth. The other is a curved line method, sometimes called the asymptotical method, in which the same yearly rate of depreciation is used but is applied to the remaining value each year. Other methods use a varying rate of depreciation, generally starting with a higher rate and gradually reducing it. This builds up a reserve much faster in the earlier and presumably most productive years of the machine, and annual increments to the reserve become less as the machine requires more repairs and up keep.

Analyse New Improvements

The wisest course for a mill owner, or agent or manager is to keep himself well acquainted with the latest improvements in machinery, etc. and it is absolutely in his own interest to analyse any new improvements in the light of adapting same for the use of the mill or for replacing the old ones by taking into consideration the difference in production, and cost, and should he find the difference to be profitable then it is left to him to decide whether the old ones should be replaced by the new ones or not. Take for an example, the modern high speed winding and warping machines or the Leesona high speed winding and warping machines in which the cost of labour can be saved up to 20% if large bobbins are used.

A textile machine is not unlike a bond or a stock. Its purchase requires a capital expenditure and its purchaser expects an adequate income from the investment by means of increased profits from faster production and lessened overhead expenses. It is the seller's problem to prove that the machine will return sufficient income to justify its acquisition, and it is the purchaser's opportunity to act after he is convinced that the possibility for income and profit does exist.

Interest on Investment

The interest on investment should be included in the manufacturing cost—a fair rate of interest being 6% on the value of the plant, stock-in-process, finished stock, and money on hand for operating.

Waste Cost

The main cost in working in a cotton mill is the waste cost particularly, in India. Waste may be described as an expenditure without necessity or use. This may occur in any manufacturing process in a variety of ways; material in process, power, machinery and stores, labour and space. The effect of waste of material on cost has several bearings; the primary loss of material and its increase in cost of raw material, which is its exact effect on cost, and can be easily reckoned up; the effect of waste on the production, that is, the reduction of labour and machinery results in proportion to the amount of wastage of the materials experienced, which is difficult of expression in currency terms, and still the more elusive one, the moral effect of unnecessary waste.

Sale of Waste

In selling waste, due consideration must be given to the following points, (*a*) the purchased price, (*b*) cost of manufacturing up to the point where it was wasted, (*c*) cost of carrying backward and forward, (*d*) loss of manufacturing profit on non-sale of same as yarn or cloth.

Cotton

As each consignment of cotton arrives at the factory or mill, it should be given a 'lot number' and each bale ticketed after they are weighed. All charges of handling should be debited to the 'cotton account' so that the total cost per pound of each consignment of cotton can be obtained. Each lot will be entered on separate sheets of the book (preferably loose leaf book) and as the cotton is issued or used, the mixing clerk will credit the lot with the cotton used.

First Process for Costing Purposes

As the cotton is passed from the 'cotton godown' to the 'bale opener,' it should be weighed and the net weight of bagging and ties noted in the book, and compared with the weights that were taken when first received.

The following informations are necessary to be kept and a copy supplied to head office :—

(*a*) Weight of cotton put through.
(*b*) Weight of cotton laps produced (care should be taken that when a lap has to be put through again owing to incorrect weight, this should not be entered in the weight produced).
(c) Waste (visible and invisible).
(d) Percentage of waste to weight of cotton.
(e) Saleable waste.
(*f*) Mixable waste.

In the case where various grades of cotton are used and mixed, the cost of each mixing will be required. Assume, three mixings are being used, therefore daily particulars will be required as follows :—

Weight of cotton no. 1 mixing, giving lot no., number of bales, price of cotton and cost per pound.
Similarly, for No. 2 or 3 or 4 mixings.

Second Process for Costing Purposes

As the cotton laps are passed from the 'scutcher,' the nett weights should be entered by the 'blow room clerk' in the book and thereafter on a report provided for the purpose. The waste produced each day should be carefully weighed, and these weights entered in the book as well as in the report. A record should be made of

idle machine time in hours. Assuming that two carding machines have been idle for one day each and working day is one of nine hours, the idle time would be eighteen hours.

In this manner a check is put on the idle time.

Summary of the daily reports will be as follows :—

1. Total weight of cotton laps put through.
2. Waste produced.
3. Nett production.
4. Percentage of waste.
5. Idle machine hours.

Third Process for Costing Purposes

It is recommended that the whole process of drawing, including the slubbing, intermediate and roving frames be taken as one process, as would be impracticable to weigh the cotton after each process of drawing. Further, unless very wide varieties of counts are produced the difference in cost of production will be near enough for all practical purposes by taking the variation from the roving frame productions. The roving bobbins can be conveniently weighed and the production of each grade of roving can be accurately arrived at. The waste produced can also be weighed.

It is essential at this stage to obtain a correct average of the various hank rovings produced, and the following method, which although simple, is very important for costing purposes.

Assume the roving frames productions for the month are as follows :—

16,000	lbs.	4.25	hank	roving.
24,000	,,	5.50	,,	,,
4,000	,,	6.50	,,	,,
44,000	,,			

The average hank roving will be :—

16,000 ×4.25	=	68,000
24,000 ×5.5	=	132,000
4,000 ×6.5	=	26,000
44,000		2,26,000

$$\frac{226000}{44000} = 5.13 \text{ average hank roving.}$$

This method must be followed in the spinning process and also in the doubling, winding and warping processes, but it should also be noted that in this latter processes the twists per inch should be averaged, and in the folded yarns, a standard should be set up recording the production according to this set standard . If the standard is a two fold yarn, all average productions must be worked out on this basis.

A daily report should be submitted to head office, in the following manner :—

(1) Nett production of the roving frames of each hank or count.
(2) Waste produced.
(3) Percentage of Waste.
(4) Average hank roving.
(5) Idle machine hours.

Fourth Process for Costing Purposes (Spinning)

A daily report should be submitted to the head office in the following manner :—

(1) Nett. production of the ring fames of each count.
(2) Waste produced.
(3) Percentage of waste.
(4) Average counts.
(5) Average test.
(6) Idle machine hours.
(7) Efficiency obtained.

EXAMPLE OF METHOD OF CALCULATING FROM THE SCHEDULE OF MONTHLY PARTICULARS THE COST OF ANY PARTICULAR YARN.

Cost of 1 lb. 2/40's on cheese.

Process.	Waste per 100 lbs. cotton.			Wages & Burden per 100 lbs. of yarn.			Total Wages, & Burden.
	Visible & Invisible.	Visible.	Value of Visible	Wages.	Burden 1	Burden 2 3 4 & 5	
Scutching ..	5.00	3.50	@ 2 As. = 7.00	4.50	1.00	6.00	11.55
Carding ..	3.75	3.00	@ 4 As = 12.00	26.25	2.00	77.10	105.30
Roving ..	.50	.41	@ 2 As. = .82	78.50	6.00	83.00	167.50
Spinning ..	1.25	1.10		132.00	31.00	171.40	334.40
	10.50						
Winding ..	1.65	1.45		89.00	.70	10.30	100.00
Twisting ..	.27	.22	3.22 @ 3As.=9.66	80.50	.70	8.60	89.80
Re-winding ..	.50	.45		87.00	.70	10.30	98.00
	12.92		29.48	497.75	42.00	366.70	906.55

Cotton commencing weight .. .. 100.00 lbs.
Less waste to spindle point 10.50

89.50
Add regain, say 5% 2.42

91.92 lbs. yarn.

100 lbs. cotton at, say 14 As. .. 1400.00 As.
Less residual value of waste as above 29.48

Cost in cotton to make 91.55 lbs. yarn 1370.52

Cost in cotton per lb. of yarn $\frac{1370.52}{91.55}$ ..14.97 As.

Cost in wages and expenses as above $\frac{906.55}{100}$ .. 9.07 As.

Add distribution expense per lb. of yarn .. .30 As. =24.34 Ans.
Add selling expense, say 4% of total factory cost 1.21 „

Total cost of 2*40's yarn on cheese.. 25.55 „

CLEAN COST OF COTTON

Price of cotton Rs. 400 per candy.

1 Candy =748 lbs. = $9\frac{1}{2}$ maunds.

Rs. 400 ÷ $9\frac{1}{2}$ =42.1 cost per maud.

Take 80 lbs to the maund instead of $82\frac{2}{3}$.

Then $\frac{42.1 \times 16}{80} = 8.4$ Annas per lb.

Another Method of finding Clean Cost of Cotton

100 lbs. of cotton =80 lbs. of yarn.

Say price of cotton is Rs. 1 per maund taking 80 lbs. to the maund instead of $82\frac{2}{3}$ lbs.; $\frac{2}{3} = 3\frac{1}{2}\%$ approximately.
Price of cotton per maund =16 annas.

16 ÷ 80 = .20 Annas per pound without waste.

Taking 20% as spinning loss = .04 (.20As. × 20%)
.20 × .40 = .24

Procedure in Figuring the Costs of Manufactured Goods

1. Preliminary steps.
   - (*a*) Allocation of fixed charges and cost of stores.
   - (*b*) Division of the departments.
   - (*c*) Arrangement of cost sheet.

2. Gathering the data.
   - (*a*) Wages as in pay-sheets or in muster-roll.
   - (*b*) Value of machinery.
   - (*c*) Power consumptions.
   - (*d*) Floor area.
   - (*e*) Building and machinery by departments.
   - (*f*) Manufacturing expense, say for a period of 12 months.
   - (*g*) Production, say also for a period of 12 months but must be for the same period as taken for the purpose of (*f*).

3. Distributing the costs.

Distribution of costs to departments.

4. Arriving at the manufacturing cost of producti on by departments, including the cost of stores.

(*a*) From openers to drawing Department.

(*b*) Slubbing, intermediate and roving frames.

(*c*) Ring twist frames.

(*d*) Ring weft frames.

(*e*) Winding.

(*f*) Warping

(*g*) Sizing.

(*h*) Drawing.

(*i*) Weaving.

(*j*) Dyeing.

(*k*) Bleaching.

(*l*) Mercerising.

(*m*) Printing.

(*n*) Calendering.

(*o*) Finishing.

(*p*) Warehouse.

(*q*) Baling..

5. Summarising the wages.

6. Summarising the costs ot stores.

7. In case of yarn :—Clean cost ot cotton and the manufacturing cost (which must include all expenses).

8. In case of cloth .—Price of yarn and the manufacturing cost including the cost of size and all other expenses.

9. Calculating the cost of each quality.

10. Fixing up the sale price of each quality.

Distribution of Fixed Charges.

Operation and administration including all expenses pertaining to them	as per register.
Total labour cost	according to muster-roll and pay-sheets.
Cost of sores	as issued to the various departments.
Electric power	floor area.
Electricity	electric power consumption.
Coal	steam power.
Water taxes	steam power consumption.
Mill repairs	floor space.
Mill expense	as per pay-register.
Taxes	value building and machinery.
Insurance	do. do.
Interest on plant and equipment	value of land, building and machinery also may include the money on hand for working or running purposes.
Interest on debts (if any) ..	..
Depreciation on building ..	value of building.
Depreciation on machinery..	value of machinery.
Selling expense	including commission, etc.

DISTRIBUTION OF PERCENTAGES OF POWER, CONSUMPTION OF STEAM, FLOOR AREA ETC., ETC.

The following informations are given so that the reader may derive therefrom the necessary ideas. The figure must not be taken for granted as "STANDARD" figures. Each individual mill must work out its own figures from actual facts.

	Power.		Consumption of steam.	Labour.	Floor area.	Machinery value.	Building value..
	Steam	Electric.					
Blow room	8.02			2.85	6.17	8.60	4.88
Carding and Drawing..	9.94			4.80	6.17	13.80	7.64
Slubbing, Inter and Roving	5.73	45.90	10	5.89	9.28	9.88	14.32
Ring spinning							
Reeling	35.56			25.95	20.66	23.47	19.09
Yarn bundling and baling							
Winding	0.54			5.16	0.95	0.60	0.84
Warping	0.21			1.62	1.65	0.48	0.64
Sizing	0.30		45	2.12	1.65	3.19	1.71
Drawing		52.10		2.75	1.43	1.67	1.49
Weaving	36.73			29.23	40.20	33.28	40.10
Calendering			15				
Warehouse	0.87			3.14	5.70	1.70	4.00
Cloth baling							
Dyeing and Bleaching..	2.10	2.00	30	2.00	3.20	2.10	2.06
Power				6.84	2.94	1.85	3.23
General				7.65			
	100	100	100	100	100	100	100

Percentages in the Manufacturing Costs of Cloth

Coal	11.7	Per cent.
Stores	16.3	,,
Labour	42.9	,,
Office and supervision	4.7	,,
Fire Insurance	2.9	Per cent.
Municipal and other taxes	2.8	,,
Interest	6.9	,,
Commission on cloth	5.9	,,
Dyeing charges	5.9	,,
	100.0	,,

BURDEN.

(1) BUILDING EXPENSE.

The first essential in the manufacture of any commodity is a suitable building, and expense under this heading should include, interest on capital outlay expended on buildings, or rent paid, repairs to premises, depreciation, rates, insurance of premises, painting, lime-washing etc. and all expense incurred in the efficient maintenance of the factory.

(2) POWER EXPENSE.

This should include :—Interest on capital outlay on the erection of the power house and plant, fuel, lubricants, engineers and fireman's wages, repairs and renewals, depreciation, and all expense in the generation and transmission of power. (The cost of power cannot be too carefully set out. How is it possible to calculate whether; say an electric drive would prove more economical than steam unless the relative interest on capital outlay, labour cost, fuel and oil consumption are carefully compiled? Yet many firms change over from one to the other without taking all these factors into consideration).

(3) MACHINE USAGE EXPENSE.

This should include :—Interest on capital outlay on machinery mechanics wages, repairs, depreciation, lubricants, tapes and banding, and all expenditures on maintenance of this machinery.

(4) GENERAL MILL SUPPLIES.

Bobbins and skips.
Lubricants.
Sundries.

(5) GENERAL ADMINISTRATION CHARGES & EXPENSES.

These should include :—Executive salaries and office wages, sundry wages, state insurance, insurance of stock, office maintenance (stationery, telephone charges, petty cash, postages, etc.), and all sundry charges not dealt with elsewhere.

(6) DISTRIBUTION EXPENSE.

This should include :—Motor upkeep, packing materials and wages, carriage outwards, and all expenses of distributing the manufactured yarn after the final process.

(7) SELLING EXPENSE.

This should include :—Salesman's salaries, travellings expenses, commision, discounts allowed, bad debts, and all charges of selling the finished product.

DESTINATION—TERMS.

The additional charges will consist of :—

(*a*) Import duty.
(*b*) Exporting agent's charges, including railway rates, sea freight insurance, etc.
(*c*) Packing.
(*d*) Difference in discount and credit terms.

A schedule of the monthly expenditure under the headings 1 to 7 should be set out as shewn in the example.

A plant Leger should be kept by every cotton mill. To commence a record, an inventory of the machines, grouping them into the processes used for costing purposes, should be carefully prepared, writing the values down proportionate to the remaining life of the machine in each case. Fast-running machinery should be

given a 20-years life, making a depreciation on actual cost of 5%. Engine-room plant should be given a 25-years life, making a depreciation on actual cost 4%. Each machine should be given a full page of the plant Ledger. The amount of depreciation should be written off each machine and any improvements added to the capital value and written off over its period of usefulness.

The date purchased, maker's name. cost and estimated life be inserted for each machine, and the date, cost value of any improvements. Stock accounts for coal, oil, machinery parts and all mill supplies should be kept, and requisition forms used for drawing them. The control of these supplies, which even for a small plant amount to thousand of rupees or pounds per annum, is absolutely necessary.

A System of Control.

The writer can assert from experience that by installing a simple system of control a great saving can be made by way of consumption of stores. A comparative statement for the past six months should be prepared and closely studied and action taken by the mill-agent or manager with the purpose of affecting economy If there is any rise in consumption or amount the reason must be found out. False economy must be avoided.

The information required each month for certain items of expenditure can be accurately forecasted and the proportionate monthly expenditure for interest on capital, depreciation, insurance, rates executive salaries can be inserted in the schedule of monthly expenses at the commencement of a new quarter for the full period. Expense wages and state insurance can be obtained monthly from the wages book summary. Fuel, oil and soap, lubricants, etc., will be obtainable from the stock book, where the daily consumption should be shown. Repairs, belting, bobbins and skips will have to be estimated, which estimate should be periodically checked. The whole of the expenses should be totalled each quarter and checked with the financial books.

Allocation of Monthly Expenses over the process.

(1) *Building Expense*—should be allocated to the processes according to the proportionate space occupied by each process. Assuming the floor space of the factory is 50,000 sq. yds. and that of the opening and scutching process is 1,000 sq. yards, thus the proportion of building expense to be inserted in the summary of monthly particulars against scutching is 1000 ÷ 50,000 or 1/50th.

The proportion to be borne by the subsequent processes will be entered in the summary of the monthly particulars against each process, and the expense under this heading will thus be exhausted. A schedule shewing the various proportions should be prepared and will remain constant, unless the factory is extended.

Power, Machine Usage and General Administration Expenses—should be allocated to the processes according to the proportionate value of the machinery used in each process. Assuming the total value of the machinery is Rs. 3,00,000 and the value of the spinning frames is Rs. 1,20,000, then the proportion of expenses under this heading to be entered in the summary of monthly particulars against the spinning process will be $120{,}000 \div 300{,}000$ or $^2/_5$.

A schedule shewing the proportions of expense to be borne by each process should be prepared, and will remain constant until there is an addition or reduction to the machinery in use.

General Mill Supplies—should be allocated to the processes where the supplies are used. The cost of the bobbins and skips should be estimated and the monthly expenditure entered on the summary of the monthly particulars against the particular processes. Drawing cans to the drawing process, roving bobbins to the roving processes, etc. Oil and sundries should be allocated to the processes where used and the monthly expenditure obtained from the stock book, which should show the monthly consumption.

Distribution Expense—should be divided each month by the total monthly production of finished yarn.

Selling Expenses—should be added as a percentage of the total monthly wages and expenses costs, and this expense will be dealt with on the final costs on the costing paper for each order. The reason for dealing with selling expense in this manner is that, in the first place, it is an expense quite apart from manufacturing cost, and secondly, the expense will vary according to the value of the yarn, as items, such as commission, discounts, etc. are based on price and not weight.

It will now be clear to the reader that the schedule of monthly particulars provides all the essentials for the sectional monthly comparison. Any inefficiency will be immediately discernable to the executive. The only point now to be dealt with is the general control of material, without which it is impossible to check the

figures giving the waste of various processes, and to ensure that there is no leakage; a general co ntrol of material is required. It is suggested that a "control of material account" should be prepared monthly.

An inventory should be taken every month of the loose cotton in process. The cotton on the machiners if all constantly clothed, can be ignored for this purpose. As the yarn is spun it should be transferred to the yarn stock account, and each quality and count given a separate folio in the stock ledger. As the yarn goes out these accounts will be credited as sales, or, if a weaving plant is run in conjunction with spinning the yarn from the stock room will be transferred to the weaving department stock books.

In all statements within a narrow margin the total columns should agree. If not, strict enquiry should be made into the figures of waste given on the daily reports.

Weaving Wastage.

If cotton can be produced free from faults, and a yarn could be spun out of it that would not break in the loom, weaving costs could be lowered very considerably, and, in some instances, even by 50 per cent.

Each breakage, whether of warp or weft, causes the loom to be brought to a standstill, and thus causes loss of production, and also, according to the skill of the weaver, each breakage has some effect upon the quality of the cloth produced. In making an average quality of cloth, the loss in production caused by threads breakage, due to faulty yarn, is about 15 per cent., but in very high quality cloths the loss in production is often as high as 50 per cent.

The control of the production and waste produced by weaving department should be worked entirely separate from the spinning department, as it is only by this method that an efficient control can be established. All yarn obtained from the spinning department should be got by a requisition to be handed to the spinning master who will credit each lot in the yarn stock account book. The weaving master should also keep a regular account of the yarn received by him from the spinning department.

The particulars required to be kept by the weaving master are as follows :—

(1) Production of the looms, in lbs. in pieces, and in yard as shown below :—

In some plants the actual production can be obtained by pick counters, in which case the daily readings can be taken and converted into yards.

(1) Waste produced. The waste should be collected daily and recorded carefully.

(2) Percentage of waste to production should be reckoned up.

(3) Idle machine hours.

The final processes, such as calendering, finishing, folding and pressing can be grouped or dealt with singly to suit the management and who should supply the following particulars to the Head Office.

(1) Production.

(2) Idle machine hours.

A summary of monthly particulars can now be prepared and should follow the lines of spinning summary.

A weight control on the line suggested for cotton spinning can now be prepared with columns as follows :—

(1) Yarn received from the spinning department.
(2) Material in process at the commencement.
(3) Total.
(4) Production.
(5) Waste produced.
(6) Stock.
(7) Stock-in-process.
(8) Sales during the period.

Wages.

The summary of the wages book should be extended to cover the preliminary processes, the weaving and subsequent processes.

Burden.

The allocation of the burden can be accomplished in the following manner :—

Building Expense.—From the explanation dealing with this in the spinning department the cost is obtained monthly. It should be split up over each process on the basis of sq. yds. of floor space occupied by each process for costing purposes. This will now bring in the weaving and all the processes pertaining thereto.

Power Expense and Machinery Upkeep.—An inventory of the productive plant of the factory will have to be taken, and the proportion of the monthly expense will be allocated to the processes for costing purposes in proportion to the value of machinery used in each process.

Mill Supplies.—From the requisitions the supplies will be charged to each process.

Distribution Expenses—should be charged on an even distribution per lb. or yard of cloth produced.

Selling Expenses.—The allocation of this expense should be added as a percentage of total factory cost. To obtain this the value of the cotton used during the month should be obtained, the wages and burden under headings, building expenses, power expenses, machine usage expense, general mill supplies, general administration charges and expenses totalled. The selling expense is thus obtainable as a percentage of this figure. It can thus be calculated on the cost of each individual order.

Brokerage and Commission.

(*a*) "*Yarn*"....Local yarn brokerage is $\frac{1}{4}$% and discount $\frac{1}{8}$%. Imported single yarn brokerage is $\frac{1}{4}$% and discount $1\frac{3}{8}$%. Imported double yarn brokerage is $\frac{1}{4}$% and discount $\frac{1}{8}$%.

(*b*) *Piece goods*"....$\frac{1}{4}$%, but for greys sold by the pound is $\frac{1}{8}$%. coloured and fancy goods is $\frac{1}{4}$%.

Goods sold by the piece, $3\frac{1}{8}$% is given for payment in 3 days. Additional brokers between the merchant and the mill receive $\frac{1}{4}$% and Cloth Commission of $\frac{1}{2}$% to $1\frac{1}{2}$%.

Here may be added that brokerage and commissions differ from mill to mill and district to district but for the purpose of costing it is safe to take 1 piece or 3 pies per pound.

Basis of extra charge for wider widths of Dhoty Border (Fancy).

For $1\frac{1}{4}''$ Border add $4\frac{1}{2}$ pies over the rate of $\frac{5}{8}''$ Border which is found by actual cost.

,, $1\frac{1}{2}''$,, ,, 6 ,, ,, ,, $\frac{5}{8}''$,, ,, ,, ,, ,,
,, $1\frac{3}{4}''$,, ,, $7\frac{1}{2}$,, ,, ,, $\frac{5}{8}''$,, ,, ,, ,, ,,

For $2''$ Border add 9 pies over the rate or cost of $\frac{5}{8}''$ Border which is found by actual costing

,, $2\frac{1}{4}''$,, ,, $10\frac{1}{2}$,, ,, ,, ,, $\frac{5}{8}$,, $''$,, ,, ,, ,, ,,

If Nuki Border Dhoty minus 6 pies than the rate of $\frac{5}{8}''$.

Similar basis as above but so much per inch of border may be established for Plain Border Dhoty.

Basis of extra charge in Inches for various withs of Dhoty Borders.

For $\frac{1}{2}$ Inch, 9/16 Inch, and $\frac{5}{8}$ inch in accordance to actual cost and thereafter add.

For $1\frac{1}{8}$ Inch and $1\frac{1}{4}$ Inch, $1\frac{1}{2}$ annas to 2 annas extra per inch.

,, $2''$ add 3 ,, 4 ,, ,, ,, ,,
,, $3''$ and above add $3\frac{1}{4}$,, $4\frac{1}{4}$,, ,, ,, ,,

The Analysis of Cloth.

The Analsis of a Cloth Consists in Determining :—

(1) The nature of the material in which the fabric is composed. The composition of the material is the information most frequently sought. This is because each fibre has inherent qualities which its substitutes cannot entirely duplicate; for example no other fibre is identical with wool. A substitute is usually less expensive than the original fibre and for many purposes may be equally desirable. When sold on its own merits there is no cause for complaint.

Adulteration.

Adulteration means the employment of materials or ingredients which disguise as those of greater value. If cotton is substituted for wool, the purchaser would like to know the truth.

To know a fabric is to know its characteristics, composition, uses, advantages, and disadvantages. Every estimate of the value of the fabric must take into account its particular use. For example, a cotton and wool mixture may be more desirable than a wool article because of the lowered cost and the decreased tèndency to shrink.

With all textile fibres great care must be taken when ascertaining counts, sizing, etc. because of the great variations in diameter, strength and elasticity, and that all these properties vary according to the atmospheric influences.

Everything done in the way of testing must be carried out with the utmost care and accuracy. The instruments used must be clean and in good order. It is advisable that the testing be carried out by a responsible person. The object of cloth testing is to check and to determine as far as possible the resistance of the cloth to wear.

Dissection of Woven Fabrics.

(*a*) Total width, length, and weight.

When measuring the width of a piece of cloth it should be opened in the middle, the creases straightened out carefully and laid on a flat surface without a tension and then measured by an accurate measuring tape. The cloth should be measured at several places. The heavier type of fabrics such as Domestic cloth, Twills, Drills, Long cloth, Jeans, etc. measure well but the light type such as Mulmul, Muslins, Voiles, Jaconets, Mosquito netting cloth, Lenos, etc. must be measured with common sense as well as with measuring tape, on account of these fabrics being very elastic. When measuring a piece of cloth it should be measured between the selvedges to an accuracy of $\frac{1}{8}$th of an inch. The measurements should be taken in different places in the sample and the results averaged. As far as possible the manufacturer should give to the buyers full width.

(*b*) Determine the series of Warp and Weft.

Yarn should be tested for count, strength, elongation to breakage, twist, regularity, cleanliness and moisture. It is also desirable to anlyse the results, and, if possible, set t up some standard of comparison.

(*c*) Ends per inch or the Reed to be used.

(*d*) Picks per inch.

(*e*) Nature of material or materials used for Warp and Weft and colours of each kind and whether they are loose colours or fast to bleaching.

(*f*) Counts of Warp and Weft yarn.

(*g*) Weave or design of fabric.

(*h*) Finish of cloth.

(*i*) Reed Space. } allowance for contractions of warp
(*j*) Tape Length. } and weft.

(*k*) Reaonable allowances for waste.

(2) Characteristics of Fibres—Warp and Weft.

Yarns or fibres spun into threads, are either vegetable, animal, or mineral.

(*a*) Vegetable: cotton, linen, hemp, jute, ramie.

(*b*) Animal: Wools—alpaca, worsted, woollen, camel and horse-hair. All silks.

(*c*) Artificial Fibres: Viscose, cellulose acetate etc.

(*d*) Mineral: Asbestos, silver, gold, and glass.

Tests of Materials.

(*a*) "Cotton": tends to be inflammable, is non-absorbent, and soils readily. Cotton is dull and limp in comparison with wool or linen. In a mixture it usually appears dead white, while wool is creamy; linen shows a lustre and natural creaminess peculiar to itself. Mercerized cotton soils less readily than unmercerized cotton, because it is smoother; it takes and holds dye better, and is stronger and more lustrous.

(*b*) "Wool": has a springiness or resiliency which cotton does not possess. There is a distinct hardness and heaviness about

woollen cloth that is mixed with cotton. Cotton mixtures are usually inferior to wool because they tend to soil readily, to fade and wrinkle. They give less warmth and are not so beautiful.

" Silk." When pure, is the strongest textile fibre known. But chemicals usually in the dyeing operation, crystallize and cut the fibres, or, when in contact with perspiration or salt air, decompose and thus destroy the fibre.

(c) " Rayon : Should not pass for silk, because it is a vegetable fibre. It is usually compared to silk less expensive and not so strong. It is the fifth textile fibre and the production of rayon is greater to-day than that of pure silk. It is manufactured from cellulose (wood pulp or cotton linters) it has the nature of vegetable fibres; it can never be like silk because its chemical composition is different. The two fibres can usually be distinguished by physical characteristics. It has a higher lustre than silk (dull rayon is an exception). If two pieces of cloth or Skeins of yarn is compared (other factors being equal) the rayon is heavier. If two fibres or filaments are compared even with the naked eye, rayon will be found to be coarser than silk (except Bemberg). It feels stiffer is less elastic. It breaks readily and thus, showing lack of strength. It must be borne in mind that it loses strength when wet and returns to former strength when dried. This fact must be remembered when washing materials made of rayon which should be handled carefully while wet. White rayon has an advantage over pure silk when materials must be washed frequently; it remains white after repeated washings, whereas silk turns yellow.

" Cotton and Silk " : are used to combine cotton warp with spun silk weft. For example in silk and cotton crepe, fancy border sari.

" Cotton and Rayon " : are frequently combined as cotton warp and rayon weft in either plain weave or fancy striples.

Examination of Fibres.

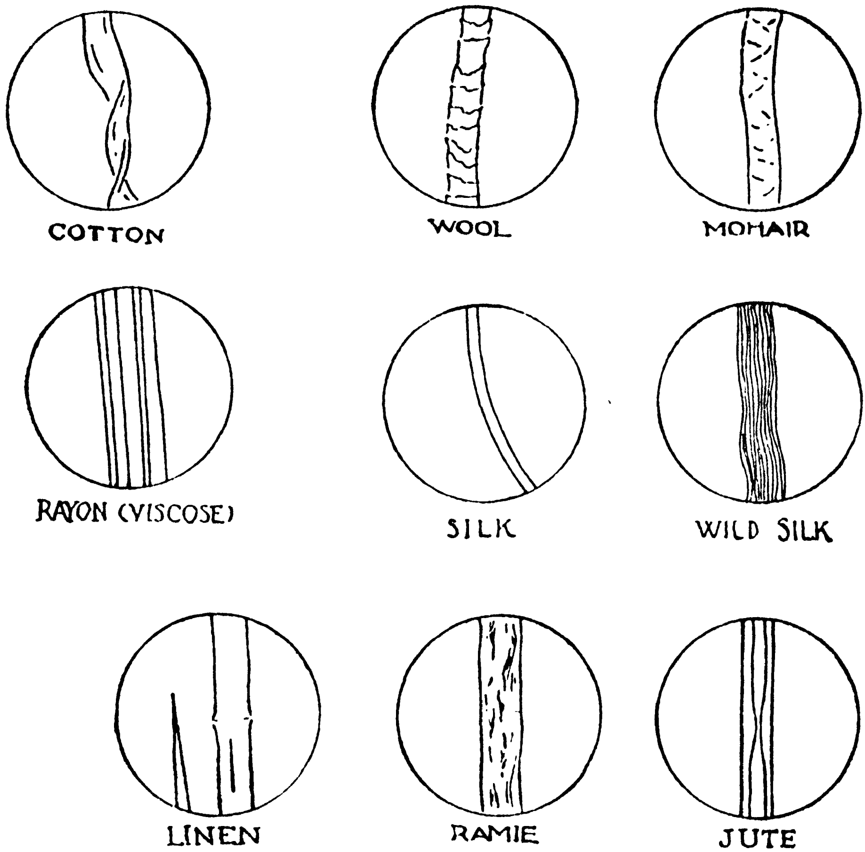
This can be carried out either by 'Observation' or 'Burning test' or 'Chemical test' or 'Microscopic test' singly or in combination.

Use of the Microscope.

All fibres have a distinctive characteristic when seen under a microscope, and such an instrument should be in the possession of all spinners, and manufacturers. A microscope with a magnification power of 300 diameters will be found good enough.

When examining fibres, the operator must, be familiar with the characteristics marking of each of them.

MICROSCOPIC DRAWINGS.



Descriptions of various types of fibres under the Microscope.

"*Cotton.*"—is a hollow fibre with a thin cell wall, flattened and twisted. The number of twists per inch vary widely in different grade of cotton.

"*Wool*"—The fibres show epidermal scales which appear faintly in mohair.

"*Rayon*" (Viscose variety)—is about four times the diameter of silk and shows lengthwise parallel markings. It appears smooth like a glass rod.

"*Silk*"— is like a solid glass rod with a smooth surface reflecting light.

"*Wild Silk*"—is easily distinguished from cultivated silk. The former is broader, uneven in width, and has fine parallel lines.

"*Jute*"—has stiff, cylindrical fibres. Walls irregular in thickness and a larger central channel, straight fibres like grasses, smooth and round ends.

"*Flax*"—is cylindrical and regular, with knots like bamboo at regular intervals, walls of fibres uniform in thickness and a fine internal channel, ends of fibres fine and tapered.

"*Hemp*"—Similar to flax, but the ends of the fibre are flat, large and thick.

"*Lanital*"—A protein material whose elementary chemical composition is somewhat similar to wool, except that the sulphur content is only about 0.7 per cent instead of nearly 4 per cent for wool. Under the microscope the fibre is fairly smooth and equivalent in diameter to the wool fibre. There is little or no crimp or scale formation.

"*Linen*"—may be positively identified only by means of the microscope. The fibres are long and straight. The fibres may or may not show joints similar to those in bamboo.

Ramie (*China grass*)—which is the yarn resembles linen, is much broader and more irregular in structure.

Jute, hemp, flax and ramie are bast fibres, that is, form part of the stem or stalk, whereas cotton is a seed hair.

Grades of Cloth.

(3) The Ends and Picks per inch or other unit. In comparing two grades of cloth for durability, the closeness of weave is an important factor. This is determined by counting the number of warp and weft yarns per inch which is usually done by means of a pick glass which is a magnifying glass.

Some people count every thread that can be seen, whilst others start with the first full thread. The safest method of counting the number of threads of warp or weft is by using a 1 in. square glass or a travelling glass known as the "Microscope" counting glass. It is fitted with a strong magnifying eye-piece adjustable to any sight, combined with a fine pointer which is traversed along a divided plate by means of a thumb Screw. The plate is marked on one side in inches and divisions, and on the other in millimetres.

Woven fabrics, particularly cotton, count better more often than not, near the selvedges than in the middle of the piece, owing to a little greater Shrinkage.

Face of Cloth—How to Distinguish.

Dobbies have the pattern more prominent on the face. The The effect or lustre obtained from calendering and when a definite finish is prominent. Sateens show face by weft on top. Cords are more pronounced on the face. Cloths with colour are brighter on the face.

(4) The Weave or Structure of cloth which may be any of the following types.

- (*a*) "*Plain*"—Rib (poplin).
- (*b*) "*Twill*" -2 &2 (Serge), Shirtings; 2 abd 1 (Drill) Herring-bone Fancy twills for coatings.
- (*c*) "*Satin*"—Warp face (Satin fabric), Weft face (Sateen).
- (*d*) "*Figured*"—Small geometric patterns, Jacquard.
- (*e*) "*Pile*"—Turkish towel (looped), Warp pile (velvet)-cut weft pile (corduroy)—cut.
- (*f*) "*Leno*"
- (*g*) "*Double cloth.*"
- (*h*) "*Novelty weaves*"

(5) The quantities of each colour, if more than one shade has been used and the extent of its fastness and also its 'tensile' Strength.

(6) The weight per yard or per piece or per lb.

(7) The kind of finish the cloth received.

- (*a*) Calendered—Ordinary, or Felt or Embossed.
- (*b*) Filled—Back filled or otherwise.
- (*c*) or both filled and then calendered.

(8) Other treatment which the yarn or fabric may have received

- (*a*) Mercerization.
- (*b*) Dyed in various colours.
- (*c*) Printed in various designs and colours.

Construction of Cloth

All woven fabrics are constructed from at least two distinct series, or groups of threads, these threads cross and interlace each other in a prescribed manner, according to some prearranged scheme of interlacing termed the weave, or design, thus a cloth may be a plain weave, twill weave, Satin weave, etc.

The threads running lengths of the piece constitute the warp series, and those running across the piece are termed the weft series.

Indications for Warp and Weft yarns in a piece of cloth.

" Warp " Shows ;—Reed marks, yarn spun twist way, the harder twisted yarn, Sized yarn, warp is generally straighter in the cloth than weft, coloured stripe, Selvedges, several counts of yarn in one series, two or more fold yarn, crammed ends in one way, if the checking pattern is longer one way than the other.

" Weft " Shows ;—Irregularity of threads, softer spun, seldom sized, threads closer together than others. If the warp thread is found from the indications given above then it is easy to tell the weft.

The warp threads are often termed "Ends" or "Twist" whilst the weft series are termed "Picks."

There are two great classes of woven fabrics :—

(*a*) Those which contain relatively an equal number of Warp and Weft threads.

(*b*) Those which contain relatively an unequal number of Warp and Weft threads.

Each of these cases may be sub-divided thus :—

(*a*) Where thickness of warp and weft threads is equal (*b*) where it is unequal.

Any alterations in the counts of yarn involves a modification in the counts of Reed and number of Picks per inch and vice versa.

Where only a slight increase or decrease in the weight of cloth is necessary then either increase or decrease the Ends and Picks, or slightly increase or decrease the counts of Warp or Weft (or both).

The other considerations are :—

The quality, elasticity, strength, and the amount of twist in the materials used.

The "Strength" of a yarn is represented by the amount of force which it is capable of resisting up to breaking point.

The "Elasticity" of a yarn is represented by its "regain" after being subjected to tension.

Twist is put into yarn primarily to increase its strength.

"Details required for Calculating the Cost of a Piece of Cloth."

(1) The 'Width', 'Length,' and 'Weight,' These particulars generally given with the order.

'*Width.*'—Note should be taken whether it is 'Nominal' or 'Full' and these terms are abbreviated to 'N' or 'Nom' and 'F.' The former may be slightly below the width stated and the latter slightly above the given width.

When measuring the width of a piece of cloth, it should be opened in the middle and laid on a flat surface or table after straightening carefully the creases, and then measure by the yard–stick between the selvedges.

'Length' generally vary in a piece of cloth when several pieces are actually measured even of the same class of goods. The difference is affected by moisture, elasticity and tension put on during the process of weaving etc.

"Weight" in a piece of cloth is apt to vary due to wrong use of weft yarn, over or under sizing etc.

(2) The number of Ends, and Picks per inch, that is, the Reed and Picks which are obtained by counting the threads in cloth both warp way for the Reed and weft way for the Picks. It is of the utmost importance that these particulars should be absolutely correct, as an error of 3 or 4 threads or picks per inch would be responsible for making the resultant and reproduced fabric a higher or lower quality than the one imitated or matched.

In actual practice it is better to count on the full inch in the counting glass and this should be done by placing the edge of the counting glass parallel with a warp thread and count every thread that can be seen.

For some makes of cloths it is sometimes difficult for the eye to concentrate to count a large number of threads and one is apt to get the incorrect number . For such cloths a counting glass having a pointer traversing by means of a quick thread screw revolved by a large milled disc is very advantageous. The pointer can indicate the position while the eye has a rest. In the case of a drill cloth which is a three end weave every three could be counted as one end and the result multiplied by three. The same applies for four or five end weaves.

Another method sometimes adopted is to have a box fitted with a glass top and within is an electric light. By placing the cloth on the glass and switching on the light each individual thread is shown up..

Reed....The number of threads in the reed or warp way of the piece are sometimes given on the full inch as for an example 60 and other times on the quarter inch as 15. In both methods there may

be a departure by stating 60, 2 or 4 down represented thus 2/60 or 4/60 or 2/15 or 4/15. This means that the 2/60 has to count 58 threads on the counter and the 4/60, 56 threads and the same on the quarter-inch basis, the 2/15 would have 58 threads and the 4/15, 56 threads to the inch.

Picks......In this case also the number of threads are stated to the inch or the quarter-inch and may be either full number of threads or two or four down. The remarks given under Reed applies in this case too.

(3) The counts of warp and weft yarns are obtained by testing the required number of ends cut to a template on a fine balance. The chemical balance with a rider attachment is the best and most reliable means of ascertaining the counts of small or large lengths of yarn..

The cloth is cut to the size of a template 4.32 inches square and then sufficient number of threads are extracted to balance one grain. The number of threads thus balanced accurately denotes the counts. The threads from most cloths will be slightly longer than template when widthdrawn, being in a "way" line in the cloth, and for this a slight allowance must be made according to the kind of cloth. Generally one count in 20 or about 5 per cent is allowed.

The method of ascertaining the size of the template and the weight is based on the fact that the number of hanks of 840 yards in one pound equals the counts and that there are 7000 grains to a pound weight. Take one grain as the weight and the length is 1/7000 part of a hank is $840 \times 36 \div 7000 = 4.32$ inches for cotton.

$$\text{Linen} = \frac{300 \times 36}{7000} = 1.543 \text{ in. nearly.}$$

$$\text{Worsted} = \frac{560 \times 36}{7000} = 2.88 \text{ in.}$$

A similar template for other fibres than cotton Linen and Worsted can be made. A mechanical balance known as the yarn and cloth quadrant is used for finding out the counts of yarns and weight of a piece of cloth. The size of the template is roughly $3\frac{5}{8}$ ins. In this method the cloth is cut to the size of the given square template and if this square piece of cloth is placed on the hook a pointer denotes the weight of a square yard on the marked quadrant.

This weight will be found very useful for checking purposes when the calculations are made for the weight of warp and weft.

To obtain the counts of warp and weft, take out 40 threads from the cut square piece and place them on the hook when the pointer will indicate the counts on the quadrant. In dissecting cloth $12\frac{1}{2}$ per cent must be deducted from the actual counts obtained on balance to allow for shrinkage. Six per cent is enough for coarsely woven cloth.

Another method which is simple and fairly accurate is to take out of the sample to be matched, say, ten threads a few inches long, then take the same number from a cop or bobin of known counts, cross the two and twist tightly. By passing these through the thumb and finger it can be felt if the two twisted strands are of equal counts. If the first trial is not satisfactory, it can be repeated with other known counts until satisfied. It is essential that the known counts should be correct and kept marked for reference.

Yet another method is to extract few threads from the sample say 20 threads $2\frac{1}{2}$ inches long. Multiply $20 \times 2\frac{1}{2} = 50$.

Then take 50 inches from a known bobbin or cop and balance it against the unknown count. Say the known counts is 20s and only 16 threads of the unknown yarn are required to balance, then the counts required is 16s.

Useful Constants.

Q. If 12 yard of yarn weighs 5 grains find the counts?

A. Rule :— $$\frac{\text{Yards} \times 100}{\text{grains} \times 12} = \text{Counts.}$$

$$\frac{16 \times 100}{8 \times 12} = 16.6 \text{ Counts.}$$

If inches then as follows :—

$$\frac{\text{Inches} \times 100}{36 \times \text{grains} \times 12} = \text{Counts.}$$

Here the constants $\frac{100}{12}$ represent 7000 grains and 840 yards. that is

$$\frac{7000}{840} = \frac{100}{12}$$

Q. Suppose a sample 2 in. ×1 in. be submitted by a merchant for the purpose of matching and this samp.le must be preserved for copying the design etc. How would you proceed to find the counts of yarns ?

A. I would take 8 threads of warp and weigh it and I would do the same in the case of weft.

Then 8 threads of warp ×2 =16 in. weight = .10 grain.

8 „ „ weft ×1 =8 „ „ = .14 „

$$\text{Then}\ \frac{\text{Length} \times \text{standard}}{\text{weight of yarn}} = \text{Counts.}$$

$$\frac{16'' \times 8.333}{36'' \times .10} = 37 \text{ counts of warp.}$$

$$\frac{8'' \times 8.333}{36'' \times .14} = 13 \text{ counts of weft.}$$

7000 grains ÷ 840 standard hanks = 8.333 grains per yard of 1^s and the number of yards that weigh this standard of 8.333 grains will give the counts.

The weighings of small lengths of cotton yarn must be done with absolute accuracy.

Weight of Woven Fabrics per unit area.

Place a template $\frac{1}{10}^{\text{th}}$ of a yard square on the cloth to be tested. Before doing so lay the cloth flat on a smooth surface. The template should be pressed firmly on the cloth and then the cloth cut round with a Sharp knife. The piece of cloth is weighed directly in a chemical balance in grains and multiply the result thus obtained by .228 constant and the result will be in ounces.

For counts, allowance to be made for Bleached and Dyed cloths Bleaching reduces the weight of cotton yarns, and this varies from 3 to 6 per cent. Thus, if 22^s is indicated on the scale then 21^s may be taken for actual count. If 30^s is indicated on the scale then 32^s may be taken as the actual count.

In the case of dyed cloth for light colours the indicated counts can be taken as actual grey counts, whilst dark shades are always heavier than grey counts. Some dyed blacks are 10 to 12 per cent heavier than grey. In the case of printed cloths, if printed all over

the yarn becomes a little heavier and hence an allowance from 3 to 5 per cent, according to design, and amount of colour used, should be made.

"*Before testing for counts of yarn get rid of foreign matters.*" Bear in mind that sample meant for testing for counts of yarn on a mechanical balance must first be got rid of all foreign matters (such as size etc) before testing and to do that the cloth after it is cut to the size of the template should be boiled with a little soda ash or soap and water, then wash, boil in plain water, wash again, dry, and thus all size or filling is practically removed.

But before the cloth is boiled it should be weighed and the weight noted and also it should be weighed after it is boiled so that the quantity of foreign matters the sample contained may be arrived at in percentage which can be expressed on the weight of warp.

Size Estimation.

Weigh the cloth sample, wash in water, place in a weak solution of caustic potash and boil for about 35 minutes (use 2 oz. to 100 oz.. water). Remove sample and wash again in cold water; boil again for 1 hour in one per cent. solution of hydrochloric acid, adding water as it evaporates; wash well in cold water, dry slowly, and then allow the sample to regain its natural moisture.

After weighing and comparing the two weights, the difference will be the loss of sizing materials.

Should the sample be woven from yarns up to 40s, make an allowance 1 to 2 per cent. for loss of natural impurities during the boilings. Finer than 40s one per cent. is ample for allowance.

Test for Weighting of Coloured "Silks".

Burn a thread, and, if it does not crumble up, a metallic loading is present; if it burns up to a bead, it can be assumed that no loading is there of a metallic kind.

Burn a sample to ash. The ash should be one per cent. of the original weight, if more, some foreign matter has been added and the extra weight of ash is loading. There is very little silk in the market that is not weighted. Light coloured silk is not weighted as much as black which is sometimes loaded about 500 to 600 per cent.

Features to be considered for correct Matching.

For correct matching there are other features to consider in the warp yarn besides the counts. Many types of cloth have to be subjected to a strength test after weaving. These tests are made both warp and weft way so that it is imperative for the yarns before they are woven to be sufficiently strong to give the required woven strength. The matcher or the weaving master has to consider what quality of cotton is required to get this strength. Again, in some makes of cloth the "turns per inch" is an important point. These can be tested on the yarn twist tester which unwinds the yarn and registers on a dial the 'turns per inch', when two or more folds of yarn are used it is important to know the 'turns per inch" of both folded and single yarn and at the same time to observe the direction of the twist whether it is warp or weft twisted. In some makes of cloth these are very important points if not correctly reproduced would change the appearance of the cloth especially if for dyeing, bleaching, printing and finishing.

In addition to the above it has to be observed if there are any special features about the yarn such as carded, combed, gassed. For ordinary purposes the weft is usually spun softer than warp. In some makes of cloth with a weft face it is often found that a superior quality made from a better class of cotton is required to obtain the best effect to the cloth in the after processes.

Reed Space.

(4) The total width of cloth that is the "Reed Space" after allowing for contraction. The allowance for contraction in the width of cloth varies according to different circumstances such as the counts and character of the warp and weft yarn. The numerical density, or degree of compactness, that is, the number of ends and picks per inch; the character of the weave; climatic condition of the atmosphere as regards relative humidity; the class of cloth; amount of size on the warp yarn; tension imposed on the warp yarns, during weaving, etc. etc. Absolute accuracy can only be obtained in respect of contraction in length by measuring threads taken from a cloth length of not less than 50 inches; and in respect of contraction in width, by measuring picks of weft taken from the full cloth width. But if there is no cloth available, an approximate estimate of the amount of contraction to allow may be assumed from previous experience or by applying one or other of the following rules :—

Rules for Contraction.

(*a*) Cut a sample, say 3 in. square; take out threads of warp and weft, smooth them out without undue stretching and measure them.

Example ;—3 in. of warp in cloth gives 3.3 in. when smoothen.

3 „ „ weft „ „ „ 3.4 „ „ „

Then if the finished width is say 45 inches, proceed thus :—

$$\frac{45 \times 3.4}{3} = 51 \text{ in. Reed space.}$$

If the finished length of cloth is 60 yards proceed as follows :—

$$\frac{60 \times 3.3}{3} = 66 \text{ yards Tape Length.}$$

(*b*) *Example;*— Reed =40 Width =30″ (finished width) after Calendering—30+1 inch (allowance for calendering) = 31 inches.

On 31″ allow 7 to 8% for Shrinkage.

∴ 31+8% =33½″ Reed space.

Allowance for dyeing or bleaching or both, is made from 2 to 4 inches or as the case may be.

Shrinkage Allowances.

The following table is worked out from experience and it is given here only as a guide.

Up to	27 inches cloth width allow		1¾ ins. in the Reed
above	27 „ „ „ and up to	36″ allow	2 „ „ „ „
„	36 „ „ „ „ „ „	40″ „	2¼ „ „ „ „
„	40 „ „ „ „ „ „	45″ „	2½ „ „ „ „
„	45 „ „ „ „ „ „	52″ „	2¾ „ „ „ „
„	52 „ „ „ „ „ „	60″ „	3 „ „ „ „

The above Shrinkage allowances may have to be varied a little in the case of very coarse or very fine Reed. Some consideration must also be given to the construction of cloth and nature of yarn. If cloth is soaked in cold water for 10 minutes will shrink about 4 per cent.

Tape Length.

(5) The total length that is the Tape Length is found out after allowing for contraction in the length.

Rule ;—(A).

For cloths containing from 40 to 80 picks per inch of 26s to 50s weft, multiply the number of picks per inch by the constant factor 3 and divide by the counts of weft for a greater number of picks per inch and for coarser weft, multiply by the constant 4.

Example ;—

Picks 48 per inch weft 25s, length of piece of cloth is 24 yards find the percentage of contraction in the warp.

$$\frac{50 \times 3}{25} = 6\% \text{ contraction.}$$

$\therefore$ 6% on 24 yards $= 1\frac{1}{2}$ yards.

$\therefore$ $24+1\frac{1}{2} = 25\frac{1}{2}$ yards Tape Length.

Rule ;—(B)

Example ;—

Picks 56, Weft 18s, Length 32 yards.

$$\frac{56 \times 32}{18} = 99 \text{ Inches or } 2\tfrac{3}{4} \text{ yards.}$$

$\therefore$ $32+2\frac{3}{4} = 34\frac{3}{4}$ yards Tape Length.

But bear in mind, if the cloth is for calendering then whatever is gained after calendering so much must be deducted from the allowance made for contraction in the length that is the Tape Length otherwise the finished cloth will be longer than the nominal length.

(6) To correctly match some cloths, particularly if they are sold in the grey state, to a given weight and the difference between the yarn weight and cloth weight is size. The size is put on the warp only. The percentage varies from 5 to 100 and even sometimes over 100% is put on the Warp yarn. It must be remembered that some size is lost during weaving so that the actual percentage added in the slasher sizing machine should be more than actually is required to be retained on the cloth after weaving. Cloth for bleaching, dyeing and printing are usually sized to withstand the strain of weaving only on the principal that it is no use to add size to be washed off again.

After obtaining the details as outlined above, it is possible to calculate the exact net weight each of warp and weft actually contained in a piece of cloth of specified dimensions.

When a cloth is sold to a stipulated weight the pieces after weaving must be as nearly as possible to the required weight and on no account to be less.

The total weight of a bale must not exceed the nominal weight of the pieces contained in the bale by more than seven per cent. If it does, it means a free gift at the cost of the mill to the merchant. This must not be allowed. A strict supervision must be kept over the weights of the bales that are delivered to the bazaar or merchants.

The weight of a piece of cloth is composed of warp and weft yarn and size and the majority of the mills considers the aggregate weight as the weight of the piece. But some mills take the net total weight of yarn that is warp and weft and the weight of size is excluded. By the adoption of the latter method the weaver is not paid for the weight of size that is included in the total weight of the piece.

If the pieces come out heavy or light from the sizing department then there are two ways of adjusting the difference in weight (1) by sizing the next set either heavy or light (2) by changing the counts of weft on the loom to either finer or coarser count. Loom is not the right place for adjusting the weight of a piece of cloth. Sizing is the right place and it is there that those responsible must pay all the necessary attention. Change of weft on the loom should never be encouraged or allowed. It is definetly detrimental to the interest of the company. Because it may happen that coarser weft is to be used to make up for the under sized beams then it means substituting coton for size. But in the case of emergency it may be allowed on a very limited scale and that too it must not be continued for any length of time.

(7) *Weave*—When cloths are other than plain, weave plays an important part and the matcher of samples or the designer should have a thorough knowledge of cloth designing. In the case of drills, twills, sateens, serges, etc. the direction of twill whether left or right or whether the weft is "twist or weft way" should be carefully noted because both these have a considerable influence on the final appearance. A wrong twill or wrong twist in the weft alters the appearance. In fancy cloths it would be necessary to find the 'design,' 'draft' and 'lifting plan' to correctly match a sample.

(8) *Finish*—If the sample was dyed the type of dye used, the colour and the finish would have to be found. If printed, the pattern, colour used and the finish. In bleached cloths ther are several ways of finishing and these should be observed.

(9) *Points for considerations.*—Speaking generally, cloths that have been either dyed, bleached, or printed have undergone a change from the grey state inasmuch as the width has shrunk, the length is longer and the weight of piece is less.

If the sample to be matched is in this condition then the actual number of threads in the warp will be less when in the grey state. The number of picks more in the grey for the cloth has been pulled out longer and the weight in the grey will be more on account of the loss of size and through the washing and bleaching processes. These points must be taken into consideration.

(10) *Materials*—(1) Warp, Weft, Size, dye, finish or filling, Calendering, and packing.

(2) The waste of warp and weft in the preparatory processes, weaving, and finishing departments.

(3) *Wages.*—Winding, Warping, Sizing, Drawing-in, Weaving Bleaching, Dyeing, Finishing, Calendering, Folding and Baling.

Both fixed and piece work wages.

(4) Productive capacity and efficiency of machinery and employees.

(5) *Expenses*—Rent, taxes, interest, commission to agent and salesman, depreciation, repairs, insurance, coal, light, water, stores, office charges, officers and clerical staff, directors and auditors, postage and telegrams, travelling expenses, law charges, railway freights, stationary and printing, maintenance charges for bullock carts, cook house, (for visitors in the case of up country mills) Motors, etc.

(6) Determine the average cost of all expenses per loom per day or month and then divide the cost of each width of loom thus obtained by the number of pieces which can be produced in the full width of loom per day or month.

Another method of determining the expenses per loom for the purpose of Profit and Loss is as follows :—

(*a*) 40 (or more or less as the case may be) Spindles should be treated as one loom, fraction over half should be taken as one and below half should be omitted.

The result thus obtained should be added to the available or existing looms in the weaving shed and the total after adding both of them together shuld be considered as final total number of looms for finding out the cost of expenses per loom.

(*b*) The total expenses should be found out as follows :—

(1) Quantity and value of cotton consumed.

(2) Value of stores consumed.

(3) Value of coal consumed.

(4) Salaries paid in all departments.

(5) Taxes and all sundry expenses including postage, travelling commission, etc., etc.

(c) Divide the result obtained under (b) total cost by the result obtained under (a) total looms.

The result will be total cost per loom.

In the production of woven textures, the actual cost must as far as possible be determined in order that the manufacturer may know what price his production can be sold at so as to leave a working profit.

Profits depend largely on the amount allowed for depreciation. The surest way of reducing costs to a minimum is to first ascertain the costs.

CHAPTER LI.

COSTING.

SCHEDULE OF MONTHLY EXPENSES.

For the quarter ended 31st. March 194 .

	Jan.			Feb.			March			Total.		
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
(1) **Building Expenses**												
Interest on capital outlay.												
Repairs to premises.												
Depreciation.												
Rates.												
Insurance of Buildings.												
Painting & Lime washing												
Total.												
(2) **Power Expense**												
Int. on capital outlay.												
Repairs to Power Plant.												
Depreciation.												
Insurance of Power Plant.												
Fuel.												
Lubricants.												
Engineers&Firemens' Wages												
Belting & Ropes.												
Total.												
(3) **Machine Usage Expense**												
Int. on capital outlay.												
Repairs to Machinery.												
Depreciation.												
Insurance of Machinery.												
Lubricants.												
Mechanics Wages.												
Tapes and Band.												
Total.												

SCHEDULE OF MONTHLY EXPENSES.—(*Cont.*)

	JAN.			FEB.			MARCH.			TOTAL.		
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
(4) **General Mill Supplies**												
Bobbins and Skips												
Sundries.												
TOTAL.												
(5) **General Administration**												
CHARGES AND EXPENSES.												
Executive Salaries.												
Office Expenses.												
Office Wages.												
Warehouse Wages.												
State Insurance.												
Sundry Wages.												
TOTAL.												
(6) **Distribution Expense**												
Motor Upkeep.												
Wages of Motor driver.												
Packing material.												
Packing Wages.												
Carriage Outwards etc.												
TOTAL												
(7) **Selling Expense**												
Salesmens salaries.												
Travelling Expenses.												
Commission.												
Discounts allowed.												
Bad Debts.												
TOTAL.												

Note: It will be obvious to the reader that, by arranging the monthly expenses in sequence, a check is put on same and any abnormal expenditure will be clearly revealed month by month.

Abstract of Stores Issued to ____________ Dept.

Ledger Folio.	Serial No.	Description of articles.	Quantity.		Rate.	Per.	Amount.			Remarks.
			No.	Lb.			Rs.	As.	P.	

The above book is to be kept as a monthly abstract book in which the Stores issued to each department such as Carding, Spinning, Weaving etc., of the mills and on the last page after every department a summary is to be made of the total amount and which should be allotted to various department.

Sales Account.

	Month.						Total.	Grand Total.
Cloth sales								
Yarn sales								
Waste sales								
Sundry sales								

Abstract of Charges Book.

Engineering A/C.

Month and Date.	Wages. Rs. As. Ps.	Bonus.	Stores.	Total.	Will be detailed to				
					Carding.	Spinning.	Sizing.	Weaving.	Dyeing.

Spinning Account.

Month and Date.	Wages.	Bonus.	Coal.	Stores.	Total.	

ROLLER COVER'S ACCOUNT.

Month and Date.	Wages.	Bonus.	Coal.	Stores.	Total.	Will be detailed to	
						Carding.	Spinning.

REELERS ACCOUNT.

Month and Date.	Wages.	Bonus.	Stores.	Total.	Will be detailed to Spinning.

Grey Winding Account.

Month and Date.	Wages.	Stores.	Coal.	Total.	Will be detailed to Weaving.	

Same form or details as under G. Winding for:

Colour Winding A/c.
Pirn or Universal Winding A/c.
Warping A/c.
Sizing A/c.
Ware House (including calendering and Finishing A/c)
Dyeing and Bleaching A/c.

Establishment A/c.

Month and Date.	Wages.			Total.	Will be detailed to.	

Same as under Establishment A/c for:

General Charges A/c.
Rent, Rates and Taxes A/c.
Interest A/c.
Exchange and Discount A/c.
Insurance A/c.
Law Charges A/c.

Sundry Charges.

Sundry Charges.

Month.	Engineer-ing.	Roller Coverer.	Reeling.	Rent Rate & Taxes.	Insur-ance.	Interest.	Exchange & Discount.	Travell-ing.	Freight & Handling.	Land Charges.	Station-ery.	Gray Winding.	Colour Winding.	Universal Winding.	Warping.	Sizing.	Weaving.	Ware House.	Establish-ment.	Total. Charges

Sundry Charges.

Description Account.

Distribution of Charges.			Remarks.		Month.				Total.	Grand Total.
Carding.	Spinning.	Weaving.								
				Building						
				Machineries						
				Electric Machineries						
				Furniture, etc.						

SPINNING ACCOUNT—CARDING DEPARTMENT.

Cotton issued								
Wages								
Stores								
Coal								
Tax cotton cess								
Sundries								
Depreciation								
Total								

SPINNING DEPARTMENT.

Wages								
Stores								
Coal								
Sundries								
Depreciation								
Total								

Yarn Costing Book.

Description.	Weight. lb.	oz.	Rate.	Amount. Rs.	As.	P.	Percentage.	Remarks.
Balance on (*i.e.* Opening Balance) ..								
Cotton taken in process during ..								
Waste „ „ „ „								
Production.								
Carding waste ..								
Spinning „ ..								
Yarn								
Total								
Balance (being stock in process) ..								
Costing.								
Yarn produced ..								
Carding Charges.								
Wages								
Stores								
Coal								
Sundries								
Depreciation ..								
Total Carding charges ..								
Spinning Charges.								
Wages								
Stores								
Coal								
Sundries								
Depreciation ..								
Total spinning charges ..								
Total charges per lb. of yarn								

SPINNING.

Approximate Statement of Cost Charges for——————194

Ring Production		lb.	(20s) lb.	
Mule	do.	lb.	(,,) lb.	
Total	do.	lb.	(,,) lb.	
Reeling	do.	lb.	(,,) lb.	

Particulars.	Amount.	Cost per lb. in Pies.	Cost per lb. 20s. Conversion.	
WAGES.				
Engine				
Mechanic				
Mixing				
Blow Room				
Carding				
Waste Card Spinning				
Frame				
Ring				
Mule				
Reeling				
Bundling				
Baling				
Waste				
Sepoys				
Roller Covering				
Mill Building				
General				
Line Level				
Erection				
Weekly Bonus				
Bonus to Doffer Boys				
Allowance to Pay Clerk.. ..				
Total ..				

carried over.

continued.

Particulars.	Amount.	Cost per lb. in Pies.	Cost per lb. Nos. No. 20s average Pies.	
STORES.				
Tinsmith				
Engine				
Mechanic				
Boiler				
Mixing				
Blow Room				
Carding				
Waste Card Spinning				
Frame				
Ring				
Mule				
Reeling				
Bundling				
Baling				
Waste				
Sepoys				
General				
Roller Covering				
Mill Building				
Electric				
Erection				
Machinery Repairs				
Total ..				
Liquid Fuel Oil				
Electric Power and Lights ..				

carried over.

continued.

Particulars.	Amount.	Cost per ob. in Pies.	Cost per ob.No.20s average Pies.	
FIXED CHARGES.				
Rent				
Office Establishment				
Mill do.				
Hamallage				
Printing				
Advertisement				
Stamp and Law charges ..				
Stationery				
Insurance				
Municipal Taxes				
Office Petty Cash Expenses ..				
Mill do. do.				
Directors' Fees				
Auditors' Fees				
Sundries				
Workmen's Compensation Insurance..				
Interest				
Secretaries & Agents' Office Allowance				
Brokerage on Loans				
Do. on Yarn and Cloth Sales				
Depreciation				
Selling Agents' Commission ..				
Brokerage and Discount ..				
Total ..				
Grand Total ..				

WEAVING COSTING.

Approximate Statement of Cost Charges for——————194

Cloth produced .. lb.

Yarn warped .. „

Yarn sized .. „

Particulars.	Amount.	Cost per lb Pies.	
WAGES.			
Engine			
Mechanics			
Winding			
Universal Winding			
Cheese Winding			
Sizing			
Warping			
Twisting			
Weaving			
Folding			
Finishing			
Baling			
Waste			
Sepoy			
General			
Miscellaneous			
Extra hands and C. sweeper ..			
Mill Building			
Erection			
Allowance to Pay Clerk			
Line Level			
Total ..			

continued.

Particulars.	Amount.	Cost per lb Pies.	
STORES.			
Engine			
Boiler			
Mechanics			
Tinsmith			
Winding			
Universal Winding			
Cheese Winding			
Warping			
Sizing			
Twisting			
Weaving			
Bleaching Charges..			
Dyeing Charges			
Printing Charges			
Folding			
Finishing			
Baling			
Waste			
Erection			
Mill Building			
Sepoy			
General			
Electric			
Machinery Repairs			
Miscellaneous			
Total			
Liquid Fuel Oil			
Electric Power and Light ..			

carried over.

Weaving Costing.—*continued.*

Particulars.	Amount.	Cost per lb Pies.	
FIXED CHARGES			
Rent			
Office Establishment			
Mill do.			
Printing			
Advertisement			
Stamp and Law Charges ..			
Stationery			
Insurance			
Municipal Taxes			
Selling Agents' Commission ..			
Discount and Brokerage ..			
Office Petty Cash Expenses ..			
Mill do. do.			
Directors' Fees			
Auditors' Fees			
Sundries			
Interest			
Income-tax			
Secretaries and Agents' Office Allowance.			
Brokerage on Loans			
Depreciation			
Workmen's Compensation Insurance			
Total. ..			
Duty			
Grand Total ..			

APPROXIMATE STATEMENT OF PROFIT AND LOSS ACCOUNT FOR THE MONTH OF————19————

SPINNING.

Particulars.	Amount.			Particulars.	Amount		
Cotton				Yarn			
Electric Energy				Waste			
Liquid fuel oil				Tares			
Stores				Sundry Articles Sold			
Wages							
Rent..				Total ..			
Office Establishment ..							
Mill Do.							
Printing & Stationery ..							
Advertisement							
Stamp & Law Charges ..							
Hamallage							
Insurance							
Municipal Taxes							
Office Petty Cash ..							
Mill Do.							
Directors' Fees							
Auditors' Fees							
Income-tax..							
Interest							
Secretaries and Agents' Allowance							
Brokerage							
Depreciation							
Selling Agents' Commission							
Brokerage & Discounts ..							
Workmen's Compensation Insurance							
Balance being							
Total ..							

APPROXIMATE STATEMENT OF PROFIT AND LOSS ACCOUNT FOR THE MONTH OF——————19

WEAVING.

Particulars.	Amount.			Particulars.	Amount.		
Yarn				Cloth ..			
Electric Energy				Waste ..			
Liquid fuel oil							
Dyeing Charges							
Stores				Total ..			
Wages							
Rent..							
Office establishment ..							
Mill do.							
Printing, Stamp & Law Charges							
Advertisement & Stationery							
Selling Agents' Commission							
Discount & Brokerage ..							
Insurance							
Municipal taxes							
Office petty cash							
Mill do.							
Directors' fees & Auditors' fees							
Income-tax							
Depreciation							
Interest							
Secretaries and Agents' allowance							
Brokerage							
Duty							
Workmen's Compensation Insurance							
Balance being							
Total ..							

PROFIT AND LOSS STATEMENT.

Spinning Department.

Cost of Raw Cotton	
Loss % up to Spindle Point	
Cost of Cotton with Loss	
Wages	
Stores	
Electricity and Liquid Fuel Oil	
Interest	
Depreciation	
Other Charges	
Selling Agents' Commission	
Brokerage and Discount	
Total Charges ..	
Cost of Cotton up to Yarn	
Price of Yarn Sold	
Price of Saleable Waste, Etc.	
Total ..	
Difference being Profit or Loss	
Nett Yarn Produced	
Total Profit or Loss ..	
Average Counts Spun	
Gross Average per Spindle	
No. 20s Conversion Spindle	
Working Days	
Working Hours	
Saleable Waste made %	
Useable Waste made %	
Hands Present	

PROFIT AND LOSS STATEMENT.

Weaving Department.

Cost of Yarn Supplied to Weaving.	
Size Gain %	
Cost of Yarn with Size Gain	
Wages	
Stores	
Bleaching Charges..	
Dyeing Charges	
Electricity and Liquid Fuel Oil	
Interest	
Depreciation	
General Charges	
Selling Agents' Commission	
Brokerage and Discount	
Duty	
Total Charges ..	
Total Cost of Yarn up to Cloth	
Price of Cloth	
Price of Saleable Waste	
Total ..	
Difference being Profit or Loss	
Cloth Produced	
Total Profit or Loss ..	
Average per Loom	
Working Days	
Working Hours	
Saleable Waste %	
Hands Present	

" Important"

The specimen of statements given in the following pages are meant for monthly comparison for the purpose of watching the progress, each department is making by way of "Efficiency and Cost."

Every mill-agent and manager should keep an up to date record of all the departments as required by the statements "as a companion" with a view to find out the weak points which should be brought to the attention of the officers concerned for the purpose of rectifying them with the least possible delay.

It is indeed essential that the cost of every count of yarn and class or kind of cloth Should be worked out minutely for every process or department as one unit and kept ready for future reference for the purpose of costing without which no mill can be successful.

STRENGH OF HANDS EMPLOYED AND WAGES PAID.

Departments	Hands on Fixed wages. M.	F.	Hands on P. W. wages. M.	F.	Total	Amount of Fixed wages. Rs.	A.	P.	Amount of P. W. wages Rs.	A.	P.	Total Amount. Rs.	A.	P.	Remarks
Officers.															
Office Clerks ..															
Inside ,, ..															
Office Peons ..															
Darwans															
Cart men ..															
Lorry Drivers ..															
Miscellaneous ..															
Sweepers ..															
Sale Dept. ..															
Engine (Mech.) ..															
Do (Elect.) ..															
Mixing Room ..															
Blow Room ..															
Card Room ..															
Frame Dept. ..															
Ring Frame ..															
Doubling ..															
Reeling															
Bundling ..															
Tubular Banding															
Waste Card ..															
Mule Dept. ..															
Flat Grinding ..															
Waste															
Creche Room ..															
Stores															
G. Winding ..															
Drum Winding ..															

STRENGH OF HANDS EMPLOYED AND WAGES PAID.—Contd.

Departments	Hands on Pixed wages		Hands on P. W. wages.		Total.	Amount of Fixed wages			Amount of P. W. wages.			Total Amount.			Remarks.
	M,	F,	M.	F.		Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	
Pirn Winding ..															
Warping															
Sizing															
Drawing ..															
Weaving															
Damping ..															
Finishing ..															
Calendering ..															
Cloth Breaking ..															
Scutcher															
Raising															
Folding															
Baling															
Bleaching ..															
Dyeing															

SUMMARY OF MACHINERY

ENGINE " DEPARTMENT.

Description of Machinery.	No.	Makers.	Actual I.H.P.	Area occupied by Machinery. L.	B.	H.	No. of Doors and Windows. Doors	Windows	Details of Machinery

CARDING AND SPINNING DEPARTMENTS.

Description of Machinery	No.	S. per Frame	Total	Makers.	Actual I. H. P. Per Machine	Total	Area occupied by Machinery L.	B.	H.	No. of Doors and Windows. Doors	Win:	Details of Machinery or Remarks.

SUMMARY OF MACHINERY.

WEAVING " *(GREY WINDING ETC.)

Description of Machinery.	No.	Spindles		Makers	Actual I.H.P		Area occupied by Machinery			No. of Doors and Windows.		Details of Machinery or Remarks
		Frame	Total		Per Machine	Total	L.	B.	D.	Doors	Window	

DETAILS OF LOOMS IN THE WEAVING SHED.

Width of Loom.	Kind of Loom				Speed of Line Shaft	Pulleys.		Loom Speed			Average		Remarks.
	P.	D.B.	Dobby	Total		Driver	Driven	P.	D.B.	Dobby	Reed Space	Speed	

* Similary for Drum Winding, Pirn Winding, Warping and Sizing. In the case of Warping and Sizing substitute frame for spindle.

MONTHLY VALUE OF COTTON CONSUMED.

Months. 1941	Cotton. Bales.	Pounds	Value. Rs.	A.	P.	Loss %	Cost Unclean	Clean.	Remarks

COTTON MIXING

Kind of Cotton	Counts to be Spun 16s %	20s %	30s %	40s %	50s %	Remarks.
Total.						

COST OF MIXING

20s Warp Mixing.

194 Month	Date.	Description of Cotton.	Per cent.	Rate Per Candy Rs.	As.	Loss per cent.	Clean cost Per Pound. As.	Ps.	Remarks

MONTHLY—COMPARATIVE CONSUMPTION OF STORES.

hs	Engineering		Carding and Spinning	Winding		Universal	Warping	Sizing		Beaming	Weaving	Finishing		Calender-ing	Folding	Raising	Baling	Total Weaving	Dyeing	Bleaching	Mis-cellaneous	Mechanic Repairs	Erection Repairs	Grand Total	Ri
	Mech.	Elect.		Grey	Coloured			Stores	Sizing Ingredients			Stores	Ingredients												
	Rs. a. p.	Rs. a. p	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a p.	Rs. a. p.	Rs. a p.	Rs. a p.	Rs. a p.	

COST OF "MECHANICAL AND ELECTRICAL POWER".

ths	Cost of Power		Total	ALLOTTED TO				COST PER I.H.P.				POWER COST PER SPINDLE				POWER COST PER LOOM				Total Converted Cost Per Loom		REMARKS
	Mechani-cal	Electrical		50% Spinning	33% Weaving	8½% Dyeing	8½% Bleaching	Coal	Stores	Labour	Total	Coal	Stores	Labour	Total	Coal	Stores	Labour	Total			
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	p.	p.	Ps.	Ps.	Ps.	Ps.	Ps.	Ps.	Ps.	Ps.	Ps	Ps.	As.	Ps.	

MONTHLY CONSUMPTION AND COST OF COAL.

I. H. P. of Engine = Total Spindles = Total Looms =

Months	No. of Working Days.	Monthly Consumption		Daily Consumption		Monthly Cost			Per Day Cost			Average Consumption six Monthly.		Six Monthly Cost. Per Day.			Per Month		
194		T.	C.	T.	C.	Rs	a.	p.	Rs.	a.	p.	Day	Month	Rs.	a	p.	Rs.	a.	p.

ACTUAL COUNT AND TEST.

Count		Test	Average Production			Rate of Yarn.	Remarks.
Nom:	Actual		ozs. Warp.	ozs. Weft.	ozs. Reeling.		

MIXING, BLOW ROOM, CARD ROOM, AND FLY FRAMES DEPARTMENTS.

Months 194	Blow Room Production lbs.	Mixing and Blow Room Wages			Cost per lb.	Card and Fly Frames				Cost per lb.	Loss Per cent.		REMARKS.
		Rs.	a.	p.	Pies	Production lbs.	Wages Rs.	a.	p.	Pies	Blow Room	Card and Fly Frame	

MONTHLY SPINNING PRODUCTION

Months 194	Working Days	Spindles		Production		Average Counts	Average Production		Efficiency.	Per Spindle Production in ounces of various Counts							REMARKS
		Idle	Working	lbs.	ozs.		Gross	20s Couv:		20s	30s						

MONTHLY COMPARATIVE SELLING RATES.

THIS STATEMENT MUST BE WATCHED AND STUDIED BY THE MILL-AGENT

Very Important

Details	January 1942 Rs. a. p.	February Rs. a. p.	March Rs. a. p.	April Rs. a. p.	May Rs. a. p.	June Rs. a. p.	Six Months Total Rs. a. p.	REMARKS
Goods Delivered								
Value								
Price Per Pound								Red Ink
Blankets								
Value								
Price Per Pound								Red Ink.
Fents								
Value								
Price Per Pound								Red Ink.
Rags								
Value								
Price Per Pound								Red Ink.
Total (good and bad)								
Value								
Price Per Pound								Red Ink.

Rough Estimation of Profit and Loss.

	lbs.	Rs.	a.	p.
Cotton Consumed	= 493,018 @ 4 As. per lb.	=12,43,255	0	0
Cost of Total Production upto packing point	=3,843,13 @ 4 As. $1\frac{1}{2}$ Ps. per lb. =	9,90,980	0	0
	Total Rs. ..	22,34,235	0	0
Sale Value* Realised of the above production @ 10 As. 11 Ps. per lb.		= 26,22,601	0	0
	Difference	= 3,98,366	**Profit**	

To find approximate Profit and Loss:

(1) Find the total consumption of cotton.

(2) Less the Loss per cent.

(3) Find the value of clean cotton consumed or issued at the rate of clean cost per lb.

(4) Find the spinning cost (power + stores + labour + overhead charges) and add this to the clean cost of cotton which will give you the cost of yarn of a certain count.

(5) Find the total valve or cost of cloth produced during the month that is the cost of yarn plus the manufacturing cost of cloth.

(6) Find the amount realised from the sale of cloth to this add.

(7) The cost of cloth lying on hand or godowns or warehouse or balance of cloth on hand.

(8) Add together (*a*) total amount realised from sale of cloth, yarn or any article to (*b*) the value of balance of cloth on hand.

(9) Deduct (*a*) cost of cotton plus labour charges upto the manufacturing of cloth upto packing point if all the productions are packed) from (*b*) Realisation from sale proceeds of all kinds during that month plus the value of balance of cloth on hand in accordance to market value ruling at the time of reckoning the profit and loss account.

(10) The difference is either Profit or Loss.

N.B.—The balance of cotton on hand is to be considered as consumed because the previous year's balance (make sure) having been considered also as consumed. If not then the balance must be taken into account.

* In the principal sale value if desired at this stage other sale proceeds from other sources as waste scraps etc., may be added.

CONSTANT FOR OVERHEAD CHARGES.

Coal

Rs. 7,578 per month.
377,870 lbs. production per Month.
14,533 lbs. production per Day.
10.21 lbs. production per Loom.

3.85 Pies cost per lb. (Rs. 7,578 reduced to pies ÷3,77,870).

39.30 pies constant (3.85×10.21).

Stores—

Rs. 18,030 per Month.
377,870 lbs. production per Month.
14,533 lbs. production per Day.
10.21 lbs. production per Loom.

9.16 Pies cost per lb.

93.52 Pies constant.

Monthly Fixed Wages—

Rs. 7,700 per Month.
377,870 lbs. production per Month.
14,533 lbs. production per Day.
10.21 lbs. production per Loom.

3.91 Pies cost per lb.

39.92 Pies constant.

General Charges—

Rs. 22,585 per Month.
377,870 lbs. production per Month.
14,533 lbs. production per Day.
10.21 lbs. production per Loom.

11.47 pies cost per lb.

117.10 pies constant.

Total Constant = 289.84.

289.84÷actual daily production per loom=Overhead Charges for that particular sort for the purpose of costing.

A Quick Method of Costing Cloth.

Long Cloth No. 1551.

25" × 37 yds. × 5¼ lbs.

21s Warp	27s Weft	44 Reed	48 Pick.

Grey Warp 21s	=2 lb. 11.15 ozs.	@104 ps. per lb.	=280.47 pies.
Grey Weft 27s	=1 lb. 15.14 ,,	@104 ,,	=221.87 ,,
Grey Wind. Warping Sizing.	=2 lb. 11.15 ,,	@ 1.72 ,, ,,	= 4.63 ,,
Weaving	=5 lb. 4 ,,	@ 6.5 ,, ,,	= 34.12 ,,
General charges*	=5 lb. 4 ,,	@23.06 ,, ,,	=121.06 ,,
		Total Pies	..662.15

3 Rs. 7 annas 2 pies per piece.
10 annas 6 pies per lb.

12.56 lbs. Prod. per Loom.

$$\left.\frac{22.50}{13.07}\right\}\text{Size\%}$$

*289.84 constant ÷ Prod: per loom (12.56 lbs. = 23.06 pies per lb.

Bleached S. Cloth B. 60.

$$\frac{33}{28}\times\frac{23}{24}\times 5\tfrac{1}{8}\text{ lbs.}$$

21s Warp	27s Weft	56 Reed	53 Pick

Col. Warp 21s	=0 lb. 2.73 ozs.	@ 170 ps. per lb.	= 29.00 pies.
Grey ,, 21s	=2 lb. 9.75 ,,	@ 104 ,,	=271.37 ,,
Grey Weft 27s	=1 lb. 14.09 ,,	@ 114 ,,	=214.39 ,,
Grey Winding	=2 lb. 9.75 ,,	@1.05 ,,	= 2.73 ,,
Col. Winding	=0 lb. 2.73 ,,	@ 4 ,,	= .68 ,,
Warping & Siz:	=2 lb. 12.48 ,,	@ 1 ,,	= 2.78 ,,
Weaving	5 lb. 2 ,,	@ 5½ ,,	= 28.18 ,,
G. Charges	5 lb. 2 ,,	@18.45 ,,	= 94.55 ,,
		Total Pies	..643.68

3 Rs. 5 annas 7 pies per piece.
10 annas 5 pies per lb.

11¼th lbs. Production.

$$\left.\frac{16.70}{9.96}\right\}\text{Size \%}$$

ESTIMATE OF SAMPLE.

P. F. Est. No. ______

Date ______ 19__

Sample Submitted By ______

Origin of Sample ______

Sort ______

Reference ______

Piece No. ______

Dimensions (Nominal ______ Ins. ______ Yds. ______ Lbs.

Test on Sample

Actual Width ______

" Length ______

" Weight ______

Actual Quadrant Test

	With Size	Desized
Wt. Per 100 Sqr. Yds.		
Count of Warp		
" "		
Count of Weft		
" "		

Ends Per Inch ______

Picks Per Inch ______

Calc. Wt. of Pie ______

SPECIMEN.

Specimen to be
Pasted on in
This Space

Estimate for Weaving

Finish Dimensions ______ Ins. ______ Yds. ______ Lbs.

Loom State " ______ " ______ " ______ "

Finishing Partic's ______

Count of Warp ______ Reed ______ Reed Space

" Weft ______ Pick ______ Loom Width

Loom Speed ______ Est. Efficiency ______

	Calculated Weight	Waste	Gross Weight
WARP			
Count ______ Tape ______ Ends			
" ______ " ______ "			
WEFT			
Count ______ Reed Space ______			
" ______ , ______			
SIZE			
Nominal Weight			

Estimated Prod: Per Loom 9 hrs. ______ lbs.
Weavers Piece Work Rate ______ Pies per lb.
Yarn Dyeing ______ lbs. at ______ per lb.
Weight of Finish Per Piece ______

______

______ Weaving Master
Manager

ESTIMATED COST

	Gross Wt.	Spinning Cost Per lb. To Spl. Point	Winding Warping	Total	Cost Per Piece
WARP					
Count					
,,					
WEFT					
Count					
,,					
SIZE					

WEAVING

			Cost Per Piece
Weavers Piece Rate ______ Pies per lb. ______	=		
Jobbers ,, ,, ______ = ______ % of Weavers ______			
General Charges Per Loom Day ______ As. ______	=		
Fixed ,, ,, ,, ,, ______ As. ______	=		
Yarn Dyeing ______ lbs. at per lb. ______	=		
Cloth Dyeing or Bleaching ______ ,,	=		
Finishing ______ lbs. at ______ ,,	=		
Calendering ______ at ______ ,,	=		
Packing and Baling ______ at ______ ,,	=		
Total Mfg. Cost			

Cost Per Piece Per Rs. 100 Per Candy Mixing	Gross Wt. Yarn	Cost per piece As.

Date	Mixing Prices	Cost per piece Cotton	Mfg.	Total	Disct. & Comm.	Freight	Add other charges	Total	Total Cost Per lb.

Manufacturing Cost of Cloth

..........................194 .

Quality No. Reed........Warp........Reed Spare.......

Description. Pick........Weft........Tape Length.......

Dimension. Size %.... ..

Should be.......

Counts.	Description	Ends	Weight	Waste %	Total Weight	Rate Rs. a. p.	Cost Rs. a. p.	REMARKS
	Warp Grey ..							
	,, ,, ..							
	,, Col. ..							
	,, ,, ..							
	Weft Grey ..							
	,, ,, ..							
	,, Col. ..							
	,, ,, ..							
	Size							
	Total ..							
	Winding Grey ..							Cost Price per piece Rs........As.......P......
	,, Col. ..							,, ,, ,, lb. Rs........As.......P......
	Warping Grey ..							Selling ,, ,, piece Rs........As.......P......
	,, Col. ..							,, ,, ,, lb. Rs........As.......P......
	Sizing Grey ..							
	,, Col. ..							
	Weaving (@ 80%) ..							
	Allowance ..							
	Total ..							
	G. Charges Act: Prod:)	× Rs......As.....						
	Calendering ..							
	Finishing ..							
	Dyeing ..							
	Bleaching ..							
	Total ..							
	G. Total							
	Selling and Discount							
	Total ..							

DAILY CLOTH PRODUCTION REPORT

Dated..............194 .

Total No. of loom		Quality No.	Mill No.	Description.	Dimension				Weight				Av per loom			Light		Heavy		Efficiency.	Reed & Pick	Warp & Weft	Remarks.
Working	Sent pieces				Ins.	yds.	lbs.	ozs.	Pieces	lbs.	ozs.	yds.	lbs.	ozs.	yds.	lbs.	ozs.	lbs.	ozs.				

Total No. of looms working =
,, ,, ,, cent pieces =
No of looms not cent pieces =
Looms stopped for beams =
,, ,, ,, Weavers =
,, ,, ,, Repairs =
,, ,, ,, Weft =
,, ,, ,, Dyed yarn =

Average production = per loom working.
,, ,, = per cent pieces.
Average picks.
,, counts of yarn.
,, ,, Reed.
Summary.
Picks, looms, warp and weft looms.

Weaving Clerk, Weaving Master, Manager.

Purchaser's Cntract.

No.......

To

MESSRS. THE MILLS, CO., LTD.,
BOMBAY.

Bombay..............194

MESSRS.

DEAR SIRS,

We confirm having this day bought from you the following Cloth manufactured at your mills at the price specified, and subject to the following conditions :—

1. In case of sale of ready goods delivery shall be taken within days of date of sale.

2. In case of forward goods, delivery of the goods and of each lot shall be taken in accordance with the provisions in that behalf contained below. You shall not be bound to give any notice or intimation that goods are ready for delivery and it will be our business to make inquiries at your office and ascertain what goods are ready, and when to take delivery at the Mills. Any notice or intimation that you may give of goods being ready shall be taken to have been given merely as a favour, and shall not affect rights and obligations of the parties under this clause. Delivery shall in all cases be taken at the Mill's or at the Company's godowns as you may direct. If you despatch the goods under our instructions, the same shall be deemed to have been done on our account and at our risk, and the goods shall be at our risk and account in all respects from the time they leave the Mills or godowns as the case may be. No goods will be despatched unless all moneys due in respect thereof and sufficient sum to cover all charges thereon are paid in advance. In cases where prices are fixed for deliveries at destinations other than the Mill premises they refer only to price. Your right to deliver goods at the Mills remains unaffected. It only means that you have to pay Railway freight upto destination mentioned.

3. If delivery of any goods is not taken in accordance with the provisions of this contract, the goods shall thereafter be deemed to have been held by you at our risk as to any loss, damage, deterioration and in all other respects and on our behalf and account, and you shall be at liberty to recover from us the price agreed to be paid therefor and all interest and charges due in respect thereof as moneys or debt due by us to you and shall be entitled at your sole discretion

to sell such goods with or without notice to us at our risk by public auction and or private sale together or in lots, at such time or times, on such terms and conditions as you may think fit. If the net sale proceeds do not cover the full amount due to you in respect of such goods for price, interest, charges, or otherwise, we shall pay and make good the deficiency. If there is excess, we shall not be entitled to recover the same. If any goods destroyed and/or damaged from any cause whatsoever after they are ready for delivery to us are covered by Insurance against such destruction and or damage, and any amount is received from the Insurance Company in respect thereof, you shall be entitled to apply the amount so received towards payment of the price of the goods, and if the amount so recovered is less than the contract price, we shall pay the difference on demand. In cases of forward contracts where deliveries are made in lots we are bound to take those lots as and when they are offered. If we fail to accept and pay for the lot so offered you have the right to sell by public auction or private negotiation, the rights that you acquire with reference to the unfulfilled portion of the contract at our risk and cost as agreed herein.

4. Where goods are to be delivered in lots or instalments, this agreement shall be deemed and construed as a separate contract in respect of each lot or instalment of goods, and the rights and liabilities of the sellers and the buyers respectively shall be the same as though as separate contract had been made out and signed in respect of each lot or instalment.

5. When any samples are furnished to us of the goods to be delivered to us, any objection we may have to such samples as to quantity design, finish, colour, heading or otherwise, shall be lodged in writing by us within 8 days after the samples are furnished, and if no such objection is lodged, the sample shall be taken to have thereaccepted, and no such objection shall be made or entertained been after.

6. That we shall pay you two annas per cent. per month on the price of the goods of which we have not taken delivery at the times mentioned above as godown rent and Insurance from and after the expiration of the Period mentioned above until the date of their final delivery.

7. That interest shall be reckoned and charged to us at the rate of nine per cent. per annum on the price of the goods of which we will not have taken delivery in accordance with the provisions of

this contract from the various due dates on which delivery should have been taken as aforesaid till the date when delivery is taken and the price paid.

8. That no claim shall be admissible after delivery of the goods, whether the same be for inferiority of quality, or short weight, or damage, or deterioration or on any other ground whatsoever.

9. If you are unable to deliver the whole or any part of the Forward goods by the specified time by reason of the Mill working short time, or its being expedient to stop the Mill temporarily, or by reason of fire, war, stoppage, or hindrance in the supply of raw material or fuel explosion, accident, strike, or riot; lock-out, or other disorganisation of labour, or transport, breakdown of machinery, or inevitable or unforeseen event of any kind directly or indirectly interfering with the working, or the full working of the Mill, we are to take delivery of such bales as you are in a position to deliver (if any) and the time for completing the contract shall, as regards the bales which may not be ready by the specified time, be extended for such time as you may require to make up for delay caused by such stoppage, hindrance to or interference with the working of the Mill, or any other of the events or circumstances above mentioned.

10. If for any other reasons than those mentioned in the last preceding clause any portion of the goods are not ready for delivery by the specified time, we shall have the option either to cancel the contract in so far as it relates to the balance of the goods not then ready for delivery or to extend the time for delivery for such period as you may require. Provided always that if we choose to cancel the contract it shall be incumbent on us to give notice in writing of such cancellation within 7 days after due date for delivery of the goods not ready; and failing our giving such notice within the aforementioned time we shall be taken to have decided not to cancel the contract, and to have agreed to extend time for delivery for such period as you may require to make the balance of the goods then undelivered ready for delivery.

11. In any of the cases provided for in the last two preceding clauses we will not be entitled to make any claim for damage, allowance or otherwise; and in the event of the time being, or being deemed to be extended thereunder, all the provision of this contract shall apply equally to the extended time as to time originally specified, including therein the remedies given to you for any failure on our part to take delivery and pay for the goods when ready within the extended period, and our liability to pay interest as provided in clause 7 hereof.

12. In the event of any goods the subject of this contract or any portion thereof being destroyed or so damaged by fire, water or other cause beyond your control as to render them unsaleable while stored at your mills or godowns pending due date for delivery the contract in respect of such goods shall be deemed to have been cancelled by mutual consent and we shall have no claim whatsoever against you in respect of such goods but if the price of such goods shall have been then paid to you we shall be entitled to the refund of the amount.

13. The buyers agree to take upto 5% bales of each sort more or less than the contract including any loose pieces of each sort at the same price. Two cut pieces to the extent of 5% will be accepted by the buyers against this contract without any allowance.

Bales.	Description of Cloth	Dimensions			Nos on pieces	Pieces in a Bale	Rate. Per lb yard piece	Delivery At
		In.	yds.	lbs				

Cotton Mill Valuation.

In making valuations for cotton mills, it is necessary, first of all, to ascertain the particulars which are usually analysed under four headings—

(*a*) Land

(*b*) Buildings (construction and dimensions).

(*c*) Power plant (including shafting, piping, ventilating, humidifying apparatus, pumps, sprinkler installations, etc.)

(*d*) Machinery and equipment.

Having made a record of the particulars and quantities, the next point to consider is the pricing or valuing, which is governed by four factors :—

1. Basis costs, *i.e.*, costs ruling at the time of the valuation which may be more or less than the actual costs of the mill under consideration.

2. Condition, *i.e.*, depreciation through obsolescence, wear and tear, but having regard to maintenance.

3. Utility and service (or earning capacity) *i.e.*, quantity and quality of production, layout and general efficiency.

4. Supply and demand, which governs market value. These factors vary in their application according to the purpse of the valuation which are as follows :—

(*a*) Fire Insurance (either ordinary indemnity or replacement with new).

(*b*) Rating (for the purpose of ascertaining for Municipal Tax).

(*c*) Balance Sheet (for comparing present values with book values).

(*d*) Company formation (public or private).

(*e*) Partnership (either for introduction or dissolution).

(*f*) Transfer (as between going and coming parties).

(*g*) Mortgage and debenture (for the purpose of raising loans).

(*h*) Income Tax (for the purpose of assessments or otherwise).

(*i*) Sale and purchase (either as going concern or for breaking-up).

(*j*) Costing (for the purpose of collecting standing charges, power, labour costs).

Rates of depreciation on a given machine may change, but the factors which enter into the determination of the proper amount of depreciation should not be ignored, nor should arbitrary figures be

used, in order to improve the appearance of the situation, as some machinery may have a life as short as 10 to 15 years under normal conditions, while others occasionally have an useful life as long as 40 to 50 years. While the life expectancy of any textile machine can be reasonably predicted in so far as age and wear and tear are concerned, there is still much uncertainty when the element of obsolescence is considered. And, to add to the difficulty, it is obsolescence which, at the present time, is the principal factor in retiring machinery. A machine may become obsolete as the result of the improvement which improves the quality or increases the quantity, or reduces the cost of the products to such an extent that the machines of the old model can no longer compete. Also as a result of a radical change in the character of finish of fabrics, etc., demanded by the consumers, will render a machine useless to the industry.

The actual amount of rate of depreciation on buildings, plant and machinery, depends on many factors, varying according to the method of construction and the materials used, the grade or class of the subject under consideration. But, bear in mind that wear and tear on a wide variety of textile machinery is quite severe and even though repairs are consistently and carefully made, there is a definite limit fairly well established beyond which it is not economical to operate it, and that limit in the experience of the author can safely be taken particularly in India from 10 to 20%.

Spinning and weaving plants are constantly reaching that stage when the machinery and factory equipment is incapable of maintaining the same degree of working, necessitating the acquisition of more suitable units or groups and a ruthless scrapping of the old. Motors and tools as well as machines for opening, preparing, spinning, and doubling are often scrapped long before they have lost their market value, but on the other hand, of course, constant attention to lubrication and general upkeep may enable certain units to be profitably employed for a much longer period.

To provide for the inevitable shrinkage of asset value on a fairly generous scale during periods of trade prosperity, while ignoring decline of capital value in times of depression, is a dangerous policy to pursue, and before the balance of net profit is withdrawn from the business by the proprietor or managing agent for private or other purposes, or shared between partners in accordance with deeds, or distributed in dividends to shareholders. An adequate sum should be debited to cover wear and tear, obsolescence, intensive working, and effluxion of time.

Government Specification—Cotton Goods.*

MANUFACTURING BASIS.

(*a*) The yarns used for cottons must be evenly spun with good twist from good, clean, long staple cotton.

(*b*) Warp yarns may only be sized for weaving only.

(*c*) The goods must be evenly and well woven and defects in appearance shall not constitute a ground for their rejection.

(*d*) Only the yarn counts given may be used, the use of any other counts will be regarded as an attempt at fraud.

(*e*) Each piece is to be indicated at the end of it by coloured weft or picks.

(*f*) A margin of $\pm$ 3 per cent. is allowed on the weight provided the material or stuff is in other respects equal to the standard sample.

Breaking Strength of Cloth.*

The government and the railway companies require their fabrics to reach the standard set for strength and hence breaking strength of a piece of cloth is of great importance therefore it should be carried out by a reliable person.

The following factors should carefully be seen to before making a test :—

(*a*) Moisture—dampness to a certain extent increases the strength The atmospheric conditions should be as far as possible the same for cloth tests.

(*b*) The speed in working the machine should be inform.

(*c*) The samples must be cut very accurately, and to one size, and placed on the machine so that the jaws grip evenly

Strip Test.*

The cloth is cut a little larger than the stated size, *i.e.*, 2″ ×3″ or 8″ ×4″, and the threads withdrawn each way till correct size is obtained. It is then placed evenly between the jaws of the machine and clamped down. Then the handle is turned round until the cloth get ruptured and the test read on the dial. Goodbrand's machines are generally used by governments and the railway companies. It is motor driven. The rate of traverse and load is standardized. The size of sample to use is 7″ between the grips and upto 7″ to 9″ wide. The range of maximum test is from 400 up to 2,000 lbs.

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* These are given by way of information only.

CLOTH ANALYSIS SHEET.

Date ______________________ 194

Description ____

Dimension __________ *Ins.* *Yds.* *lbs.*

REQUIREMENTS

1. *Reed of cloth (average Reed if necessary)* ______________________
2. *Ends in the warp* ______________________________________
3. *Warp pattern (if any)* ___________________________________

____

____

____

4. *Number of patterns in the warp* _____________________________
5. *Picks per inch* ____
6. *Weft pattern (if any)* ___________________________________

____

____

____

7. *Reed to be used* _______________________________________
8. *Width at reed* ____
9. *Tape Length* ____
10. *Yards per pound* ______________________________________
11. *Weight per piece* _____________________________________
12. *Counts of warp* ______________________________________

____

13. *Counts of weft* _______________________________________

____

14. *Weave* }
15. *Harness Draft* } *To be placed on design paper.*
16 *Pegging Plan* }
17. *How calendered* ______________________________________
18. *How Finished* ____________________ *Weight of Finish* __________

REMARKS.

EAST AND WEST CO. ADDRESS

Bombay, ______________ 194

INDENT No.

Purchase made of MESSRS. ______________

as per *their/our* *acceptance by* *wire/mail* *dated* ______________

Quantity

Dimension

Quality

Finish

Heading

Border

Assortment of

Price

Fold

Make-up

Number

Stamping & Ticketing on Cloth

Stamping & Ticketing on Paper

Shipment

Marks B. S. B.

REMARKS.

"NEVER FORGET"

(1) Fathom the cause of every complaint no matter what it is or where it is carefully and zealously.

(2) Spare the oil and spoil the machinery.

(3) Lubricants are the watch dogs of production. Don't forget there are dogs and dogs.

(4) All wood and metallic surfaces of buildings should be painted and the paint kept in good condition. The same applies to such parts of the machinery as can be painted. There is an appropriate paint for each material and service and this should be ascertained from a reliable paint dealer.

(5) Lost power is power that you pay for but do not get. On the contrary it often works to your injury. Don't lose power by using poor articles.

(6) Friction costs more than lubrication.

(7) Pennies or Annas spent on lubrication may save Pounds or Rupees in machinery depreciation.

(8) Don't lie, so says the manager. It wastes my time and yours. I am sure to catch you in the end, and that is the wrong end.

(9) Watch your work, not the clock, a long day's work makes a long day short and a short day's work makes my face long.

(10) Give me more than I expect and I will give you more than you expect. I can afford to increase your pay if you increase my profits.

(11) You owe so much to yourself that you cannot afford to owe anybody else. Keep out of debt or keep out of my shop.

(12) Dishonesty is never an accident, good men, like good women, never see temptation when they meet it.

(13) Mind your own business, and in time you will have a business of your own to mind.

(14) Don't do anything here (at the Works) which hurts your self-respect. An employee who is willing to steal for me is willing to steal from me.

(15) It is none of my business what you do at night. But if dissipation affects what you do the next day you do half as much as I demand you will last half as long as you hoped.

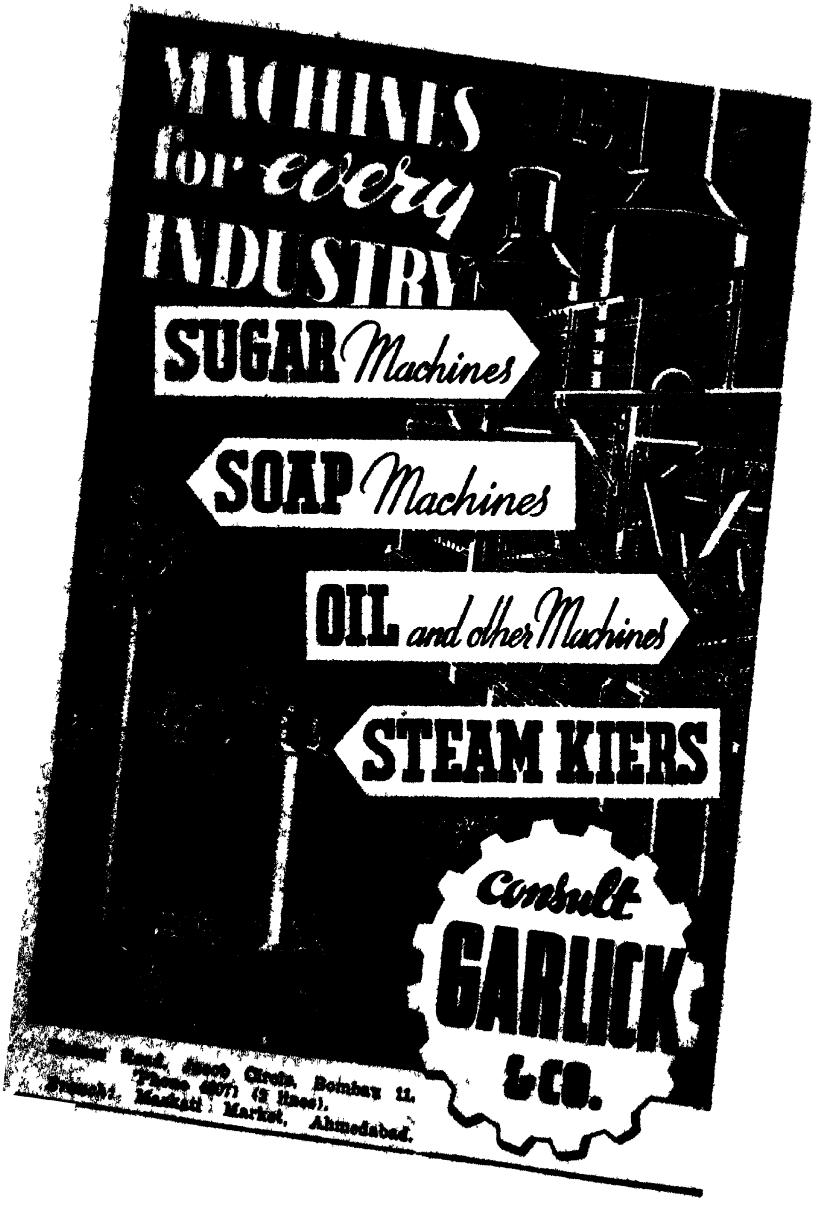
(16) Don't tell me what I would like to hear but what I ought to hear. I don't want a valet to my vanity but one for my money.

(17) Don't kick if I kick. If you are worth while correcting you are worth while keeping. I don't waste time cutting specks out of rotten apples.

(18) If you want to find fault, don't use a telescope. Try a mirror.

(19) If you have an hour to spare, don't spend it with those who haven't, I am here if it is business. If it is a funny story, I have heard it, good day.

(20) The Cotton Industry is not one either for inefficient men or inefficient organisation.


MACHINES
for every
INDUSTRY
SUGAR Machines
SOAP Machines
OIL and other Machines
STEAM KIERS
Consult
GARLICK
& CO.
Circle, Bombay 11.
Market, Ahmedabad.